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A New Compound Engine.

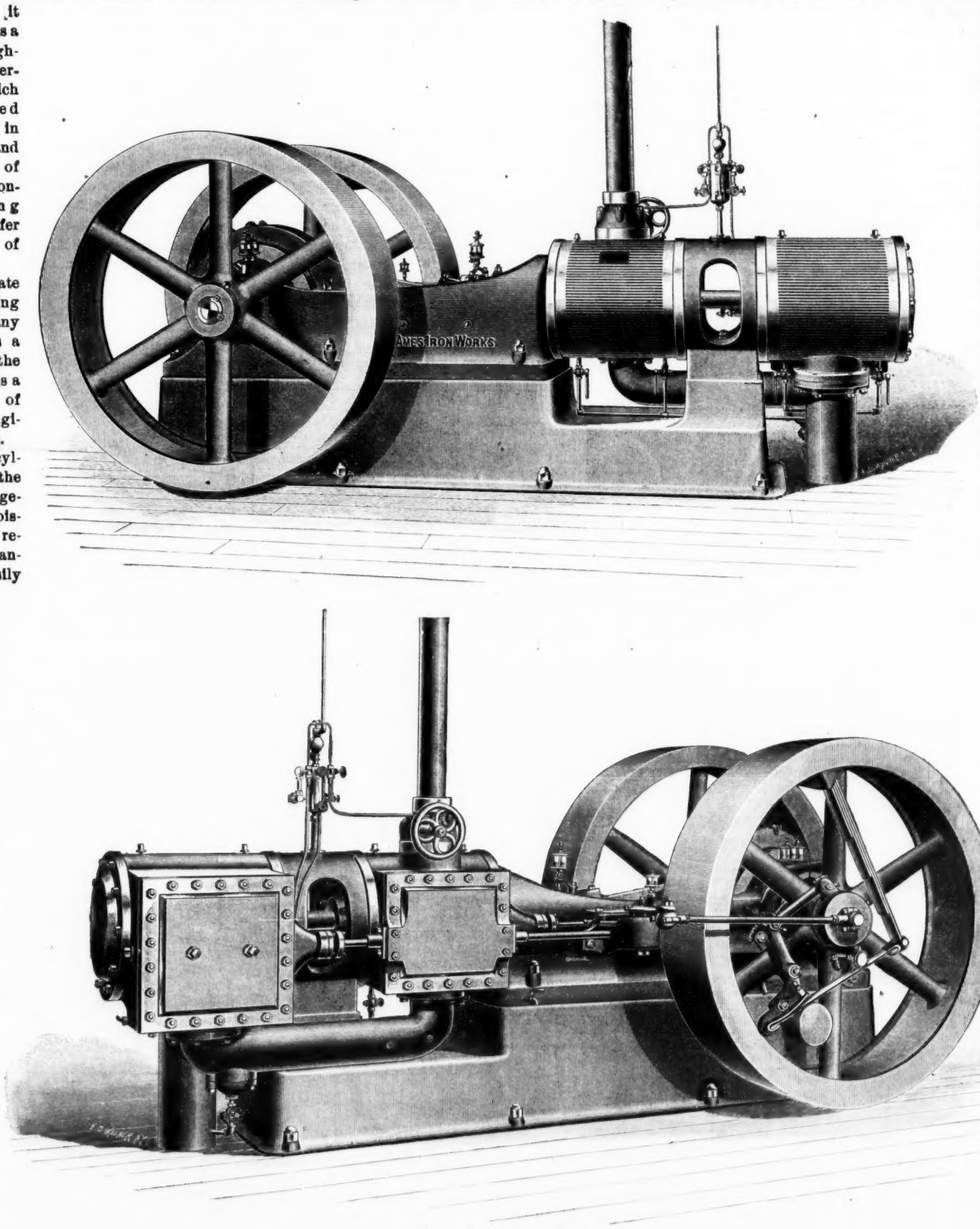
In our issue of October 12, 1893, we published illustrations and description of a new engine, designed by Mr. E. J. Armstrong, superintendent of the Ames Iron Works, Oswego, N. Y. This, it will be remembered, was a simple, single valve, high-speed, automatic, center-crank engine, in which clearance was reduced more than is common in this type of engine, and there were a number of noteworthy details of construction, regarding which we must now refer to the number spoken of above.

The engine we illustrate on this and the following page is identical in many of its details, but is a compound, and, like the simple engine, embodies a number of features of special interest to engineers and engine users.

The high-pressure cylinder is placed next to the frame, and the arrangement is such that the pistons and rod can be removed in the same manner, and nearly as easily as in a simple engine; the two intermediate cylinder heads passing out through the low-pressure cylinder. The construction by which this is accomplished is plainly shown in the sectional views on page 2, which are reproductions of working drawings of the engine.

Placing the cylinders in this manner brings the exhaust pipe out of the way, and allows the sub-base to extend well back, giving substantial support to the low-pressure cylinder.

The valve motion of this engine embodies a feature of some novelty, and, we believe, of considerable value, where the load upon the engine is variable, and especially when running non-condensing. As is well known, the two systems in general use on such engines are, first, to place the cut-off on the high-pressure cylinder only under control of the governor, leaving that of the low-pressure cylinder fixed, or constant for all loads, from the lightest to the heaviest. Whatever may be said in favor, or perhaps we should say in defense, of this method, it is sufficiently unsatisfactory to lead many builders to adopt the second method, which is to hitch both valve stems to one shifting eccentric; which arrangement varies the cut off on both cylinders in the same degree and time. The best steam distribution is, in most cases, between these two extremes, and to secure it in the engine illustrated, the low-pressure valve is driven by a separate eccentric which is under control of the governor, but which is shifted a less degree than the one which drives the high-pressure valve, so that while the latter is shifted through a range of from 0 to ¾ cut-off, the low-pressure changes from, say, ⅜ to ¼ cut-off. Both eccentrics are coupled to and controlled by the one governor, but the link connecting the low-pressure eccentric is arranged to permit of several adjustments by which the low-pressure cut-off may be made to automatically vary through any desired range, and thus the best results can be secured for any particular set of conditions.



A NEW COMPOUND ENGINE.

Metallic packing is used throughout the engine, and the piston rod packing between the cylinders is arranged so that should any leak occur it can only be from one cylinder to the other, as shown in the sectional views referred to, the trouble of maintenance and friction of stuffing-boxes in the two intermediate heads being thus avoided, and air effectually excluded from the low-pressure cylinder. All the mechanism of the valve motions is on one side of the engine, leaving the other side clear for direct coupling to dynamos; an arrangement for which these engines are especially adapted. To aid in obtaining the best results, under the wide range of conditions which have to be met, the engines are built in four different ratios of cylinder areas, and in sizes ranging from 75 to 500 horse-power, by the company above named.

Segment Work in the Pattern Shop.

BY JOHN M. RICHARDSON.

If a patternmaker should be asked what part of pattern construction had the most sameness to it, and made the workman for the time being almost an automaton in his movements, he would most naturally answer, segment work. This work being so common, and done so universally almost every day in hundreds of shops all over the country, it is almost impossible to say anything of interest concerning it, but as there are always apprentices here and there who will have it to go through, I trust they may find what I have to write of interest, and perhaps profitable.

Why are not standard patterns of pulleys, circular rings, disks, etc., made out of a solid "chunk," as some would express it, or else turned out of a solid plank? It certainly would be a very much quicker way, and in some cases more economical of lumber. The reason is twofold. The pattern, in the first place, if made in the manner mentioned, would not be strong, and would split easily, or else warp out of all semblance

to its original shape; and, in the second place, the piece would shrink, and after a time, if we should caliper our pattern, we should find, if we tried the diameter in the direction of the grain of the wood, it would measure quite closely to what it did in the first place, but if we should caliper it across the grain we should find the diameter considerably less, owing to the shrinkage of the stock, and this would be as serious an objection in many cases as the first; especially if it occurred on a pattern that was not to be finished in the machine shop after it was cast.

As the segments themselves are only an approximation to the finished size, it is not well to be too particular about them, only get them large enough, and bear this question in mind: How can I make the largest number in the shortest time?

This will not be done by sawing them one at a time on the band saw, as some old-timers persist in doing. This can hardly be called good practice, except in working up scraps.

If the segments are small and thin, band saw the shape from as thick a piece of stock as possible, then take all pieces thus made to the circular saw, and slice them up to the width required. If they are large, and $\frac{3}{4}$ inch or so in thickness, it is usually better to take a board of the right thickness to begin with, and saw it up into lengths a little longer than the extreme length of a segment, then with the template mark as many segments as possible, one beneath the other, on one of these pieces, after which take this for the top piece and place two or three (or as many as the saw will readily cut) beneath it, and hold firmly, and

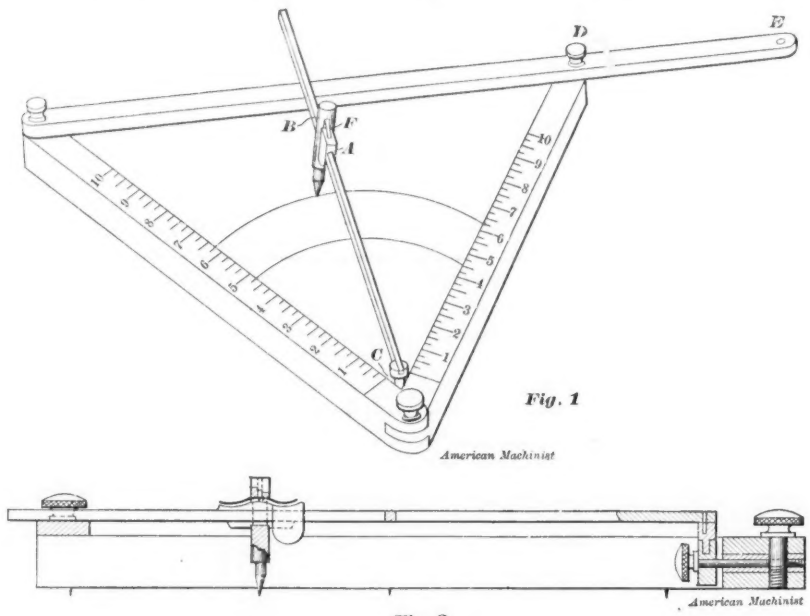


Fig. 1

Fig. 2

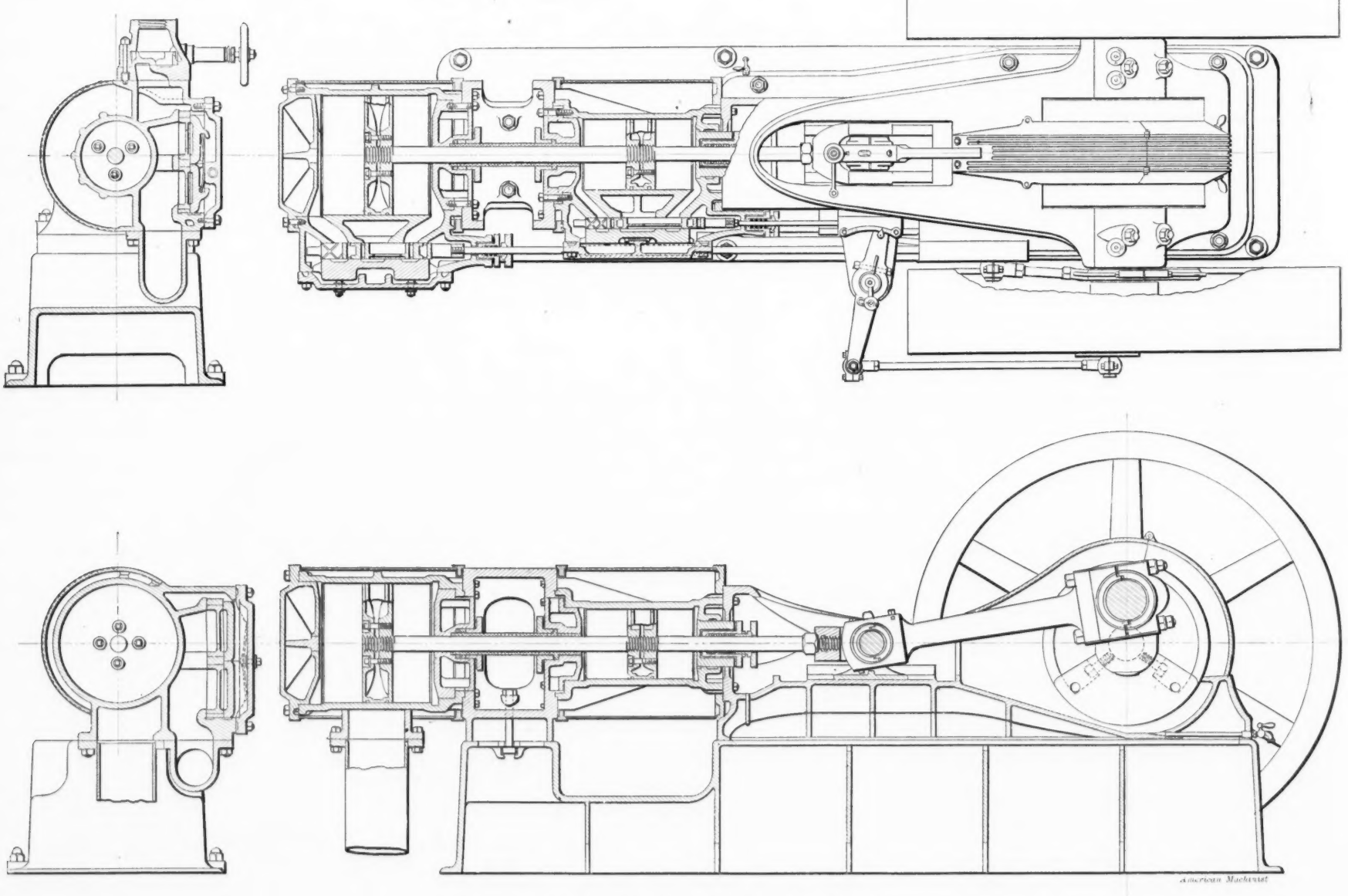
TOOL FOR LAYING OUT SEGMENTS.

or chuck, to prevent the work being thrown out of the lathe. A common method after the face plate has been trued, is to glue three strips of paper two or three inches wide, across it in such a manner that the edge is divided into six equal parts, then strike the guiding circle, and glue the first row to these strips. This is an excellent way on thin, light work, for it can readily be pried off with a putty knife after all the rows are glued on, and the piece turned. Some prefer to lay the first row to the guiding circle without glue, except at the abutting edges, and drive two light wire nails through each segment into the face plate, first remembering to cut off the heads. This method also is good for comparatively light work, and the piece can be pried off quite readily when turned, and the nails drawn from the work or the face plate, as it may happen, by means of pliers. On work of any size these expedients are not to be trusted, and it becomes absolutely necessary to put screws through the chuck into the segments, and on large work after a few rows have been glued on, these screws should be changed for longer ones.

A tripod rest usually goes with a pattern-maker's lathe to be used in turning work too large to swing over the ways, and this makes a most excellent stand (after a plug has been fitted to the hole in the top) for the face plate to swing on while clamping on the segments. Thick work is but a series of continuous layers one after another, but on thin work, especially rings, a valuable point should be borne in mind: Never make a job with two layers. Always have either three or else one. When two are used, one pulls against the other, and they will not keep their shape after being in the foundry. When three rows are used it is plainly a case of two to one, for the upper and lower layers are exactly opposite, and the middle one must succumb, thus making a job that will do good service.

If a ring is so thin that it seems impractical to glue it up in three layers, use one instead, but after the joints have all been fitted, they must be tongued as follows: Take the segments to the circular saw, and cut into both ends of each for a short distance, having the width of the opening about $\frac{1}{3}$ the width of the segments, after which they are to be returned to the face plate, and the tongues made.

These must invariably be sawed with the grain running across them instead of lengthwise, and they should be loose enough to press quite easily into the openings with one hand, for after the glue is applied they will be much tighter, and if very tight they will be sure to be broken in driving, as the grain, running as it does, makes a weak piece to pound against, and, at the same time, a very rigid tie for the joints. Sometimes on very light work (gear covers, for instance), we have a layer of segments, or, more properly speaking, sectors, meeting at a point in the center, and so thin that it is not practicable to tongue them. In such cases there is a wall of segments forming a ring about the outside, but still if the glue gives way at the center, there is nothing left to hold, as there would be if there was a hub of some kind there, so it is a good plan to turn a place at the center, about half the thickness of the web, and glue in a circular disk. This inlaid piece strengthens the pattern, and keeps the edges of the



SECTIONS OF NEW COMPOUND ENGINE.—SEE PAGE 1.

commence band sawing. It does not pay to nail the pieces together temporarily, as a little practice will enable one to hold them without trouble, if the saw cuts freely, as it always should.

There are a number of ways of attaching the first row of segments to the face plate

In turning the internal diameter of segment jobs, nearly every one has noticed the tendency of small bits to chip out at the various joints of every layer. This trouble I lay to either one or all of these three

causes—a dull tool, imperfect gluing, or bad joints. If the joints are not tight, then, of course, the pressure of the tool will tend to chip out a little piece from the first edge of a joint that it strikes, owing to the grain length being so very short on the extreme corner of the segment, and again a good deal depends upon the gluing. Glue should not be very thin for this work, for the surface covered is usually small, and the ends of the segments need more than the bottoms, as the pores of the wood are exposed there, and rapidly absorb moisture.

In order to give the ends a double quantity without having to wait to actually size them, try the following, which takes scarcely any extra time: Remove the hand clamps from a layer, and put glue on the bottom and both ends, replace and take the third, then the fifth. Next, the second should be removed. It will be seen when this is removed that so much glue has been absorbed, that hardly any has been left to hold the joint, and so in gluing the second, fourth, and sixth layers, we get twice the quantity on the ends that we do on the bottoms. If one works quickly, there will be no trouble in removing these last three layers, and if the face plate swings upon a plug in the tripod rest or stand, the job can be done about as quickly as though each layer was taken in regular order.

Figs. 1 and 2 (page 2) represent a perspective view of something which I devised some time since for marking out the first, or template segment, and it does away with the use of the trammels and straight edge, and a segment can be marked in 10 seconds or less after one knows the outer and inner radius wanted. The appliance is shown for one-sixth of a circle, but by removing the thumb screw *D* and putting it in the hole *E*, and screwing it back in the same place on the arm beneath, we can get a quarter circle. Then tighten the little thumb nut, bringing the tram bar holder back against the joint of the frame.

This position of the device is seldom necessary, as nearly all segment work is in sixths instead of fourths.

By referring to Fig. 1 it will be seen that the pencil holder *B*, and the swinging bar holder *C* are the same diameter, thus giving the end of the segment the proper angle.

A is a little wooden shoe to hold with the thumb and finger, and extends through the pencil holder, and *F* is a light spring resting upon it. The side arms are divided into ⅛ inches by shrink rule, and on the under side of them there are several little spurs, to hold the frame securely to the board while it is in use. A vertical line is scratched on the pencil holder at the point where it touches the graduations.

To operate, simply place the frame in the right position over the board, hold with the left hand, and with the right bring the pencil holder against the proper division, and swing across until it strikes the other side. Then draw towards you with the holder against the edge of frame until it reaches the division corresponding to the inner radius of segment, next swing back to the left side of frame, and forward against the edge until the starting point is reached.

This tool covers quite a range of segments and a sector can also be drawn near enough so that the part nearest the point can be easily finished by the eye when sawing.

Fig. 2 gives a section showing the method of fastening the swinging or tram bar holder to the frame.

Where and Why Compressed Air is Cheaper than Steam.

BY FRANK RICHARDS.

In this article I wish to take a rather advanced position as to the economy and general applicability of compressed air as a power transmitter, and I offer in support of it some considerations that I believe are worth weighing well. I invite the fullest and freest questioning and criticism, and if I suggest to any one the desire for some information that I fail to give, I will be happy to supply the deficiency to the extent of my ability.

In speaking of the relative cost of steam and of compressed air as means of power transmission, I of course do not forget that the air is a power transmitter only, and that behind the air compressing cylinder, as behind the electric generator, there is always the steam engine, or the water wheel, or some other means of power development, and I do not wish for a moment to be counted among the simpletons who talk about superseding steam by compressed air, electricity or any other mere power transmitter.

I have not been backward in showing that there are losses of power in the use of compressed air for transmission. Every one who has the least to do with compressed air soon gets this fact fixed in his mind. But are there no losses of power if other transmitters are employed? Is there, indeed, any means of power transmission that has not its accompanying losses? The talk about the losses connected with the use of compressed air has been overdone, and the friends of it have been perhaps too honest and frank in their statements, and the mechanical public has heard so much of the losses that many seem to think that there is nothing but loss connected with a compressed air service.

Air under pressure will leak away, of course, if careless constructors or incompetent engineers give it a chance to. The great life business of compressed air is to escape if possible, and it is this effort to escape that makes things go when compressed air gets at them One poor man has caught up this fact and run away with it, or, rather, it seems to have run away with him, and now he has air leakage on the brain, and at this writing his last public suggestion is that if compressed air were employed to operate a rat trap—a work for which it is eminently fitted—the air might get away before the rat did. The rat would not get away very soon then. Another patient in the compressed air asylum has "caught on" to the refrigerating phenomenon of compressed air, and he suggests that the air would be dangerous to use, as it might freeze up the engineer. These are only samples of how the familiar facts in compressed air practice are apt to be drawn for the gaze of the mechanical public in abnormal proportions or in sight-destroying colors.

Steam is so familiar to everybody, and is so constantly in use everywhere, that few have much to say of the losses that accompany its use. The losses exist, however, and there is a vital difference in the character and conditions of the losses by steam and of the losses by air. The losses in power transmission by air, however great they may be, are still limited, and they practically come to an end somewhere, while the losses in the use of steam are continuous and unlimited. The chief loss in the use of compressed air is in the cooling of the air after compression. When the air has become thoroughly cooled that ends the loss. Time and distance, the elements which are most prominent in the actual transmission of the power, cost practically nothing if air is used. With steam, on the contrary, every moment of time and every foot of distance are costly, and continuously and illimitably so. Steam condensation may easily become, and in an untold number of cases actually does become, a greater source of loss than the heat loss of the air. This unceasing loss by the condensation of steam is seldom actually computed or brought to a close scrutiny, so that it may be worth while to give some practical illustrations that will lead to a better appreciation of it.

With a reasonably good engine and boiler, the engine located near the boiler and using the steam with little loss by condensation, a pail of water per hour is good for two horse power. A pail of water converted into steam and transmitted through long unprotected steam pipes, and all by condensation converted back to water again, still means a possible two horse-power sustained for an hour, but it is two horse-power absolutely lost; yet pailful after pailful, and barrelful after barrelful of water condensed from unused steam is thrown away in many extensive plants without remark and without thought. Whenever the machinery is stopped it is accepted as a matter of course that time must be taken to draw the water off before starting again, and too often the thought prevails that the condensation is only going on during the stoppage and in consequence of it, instead of going on continually all day, as it does, and at the same rate all the time that the steam is in the pipes. The loss of time in getting rid of the water is also to be added to the cost of the steam in addition to the loss represented by the water itself. Where machines are used intermittently, as, for instance, hoisting engines, and especially rock drills, which are frequently stopped to change the steels, the loss of time in warming up again and in working the water off is a serious deduction from the total day's work.

I may cite three or four instances that have been recorded bearing upon the comparative losses in the transmission of steam and of air. At the Jeddo tunnel, near Hazleton, Pa., compressed air at 60 pounds pressure was carried 10,860 feet, over two miles, and gauges at both ends of the pipe showed no difference of pressure. At the Marble Cliff, Ohio, quarries a line of pipe 6,300 feet long, with air at 80 pounds pressure, showed no difference of pressure at the other end of the pipe. It would be impossible to make comparison with a steam pipe of the length of either of the above air pipes, because its function as a conveyor of steam would have ceased long before such a length was reached, so we must content ourselves with such samples of steam conveyance as we can get. A practical test of a steam pipe used in open air work gave this result: The temperature of the atmosphere was about 32° Fahr., total length of steam pipe 300 feet, of which 170 feet was 2 inches and 130 feet was 1¼ inches. With steam standing on the pipe and with no machinery in use the pressure in the boiler was 85 pounds, and at the other end of the pipe the pressure was 70 pounds. It might be thought that with the steam standing in the pipe, and with none being drawn off from the farther end of it, the pressure at the two ends should have at once equalized itself, as it does with air in the pipe. This might be so if the steam were quiescent; but the fact is that in a case like this, even with no steam in use, there is quite a current in the pipe, especially at the end near the boiler, the steam continually flowing along to compensate for the continual disappearance of it by condensation. The accumulated water in the pipe also probably served as an obstruction to hold back the pressure. It is not asserted that in this case the pipe was all perfectly level, and it probably was not. At the Allegheny quarries steam was for a long time used for operating the rock drills and other machinery. The steam was conveyed 800 feet from the boilers, and with a constant pressure of 120 pounds maintained at the boilers the operation of the rock drills was so unsatisfactory that "something had to be done about it." An air compressor was put in and compressed air was conveyed through the same pipe, and with 65 pounds air pressure maintained at the compressor, the drills were amply supplied and their action was in every way satisfactory.

This brings us to see pretty clearly one place where, or one set of conditions, at least, under which compressed air is cheaper than steam. As to all the places where compressed air would prove to be cheaper than steam, I cannot attempt to enumerate them. The actual adoption of compressed air in the work of quarrying and in making open cuts in rock, where heretofore steam has been considered the only proper motive power, speaks for itself. The cases are now becoming numerous where compressed air has been adopted in place of direct steam in open air work, and in no case has the air been abandoned, but all are united in the assertion that a great gain is accomplished by the substitution of the air for the steam. The extensive employment of compressed air in driving the machinery upon the vast works of the Chicago Drainage Canal, where the air is applied to the same machines that were previously operated by steam, and where the air is found so satisfactory and economical, constitutes a telling and world-wide advertisement for compressed air.

There is danger that evidence so strong and conclusive may, to some extent, be used to defeat itself. It may be claimed that mining and quarrying and rock-cutting machinery in general is special and peculiar, and that the success and economy of the air in such a field does not warrant us in assuming that it would be successful in other fields, and some might go so far as to argue that success here would even warrant a presumption against its success in other fields. This is absurd, you know. The machinery employed is the universal steam cylinder and the reciprocating piston, and it may be operated indifferently by steam or by air. But to accommodate and convince the skeptical, I may offer an instance of a widely different application of compressed air, and any one may judge whether it is not also an economical application of it. The following was contributed at the Montreal meeting of the American Society of Mechanical Engineers, in connection with my paper upon Compressed Air, presented at that meeting. It is furnished by Mr. Chas. D. Heggem, M. E., superintendent of the steam engine works of Russell & Co., at Massillon, Ohio:

"Compressed air has been used in these works as a means of power transmission for six or seven years, beginning with a 600-pound hoist and increasing from day to day until at present there are in operation 26 five ton cranes, one cupola stock elevator and a large number of small hoists, varying from 400 pounds to 1,000 pounds capacity. Shears and punches in the boiler shop, where out of the way of the line shafting, are being operated by compressed air. One form of shear is applied to the cutting off of stay bolts in locomotive boilers. Here by the aid of compressed air two boys may cut off 700 or 800 stay bolts per day of 10 hours, which is far in excess of what could be accomplished by hammer and chisel as formerly used."

"It is in the foundry that compressed air is more especially of service, as its elastic action makes it very convenient in drawing patterns, closing flasks, etc."

"The air is supplied by three compressors. A 10 inch x 13 inch belt driven compressor runs constantly and supplies most of the air that is used. The working pressure is from 60 to 70 pounds. A 7½ inch x 7-inch steam driven duplex compressor is operated by a pressure valve so that when the pressure of the air falls below 60 pounds this compressor is put in motion to supply the deficiency. The air supply is thus maintained automatically A smaller steam-driven compressor is kept merely as a reserve in case of accident to either of the other machines. The air is stored in three reservoirs of 250 cubic feet capacity each, and these reservoirs are placed in those parts of the works where the greatest volume of air is required. Owing to the intermittent use of the air these compressors are able to furnish a sufficient amount, and at a cost of something like $3 per day of 10 hours."

"The piping aggregates about 2,500 feet, and is 2½ inches in the main line with 1½-inch and 1¼ inch branches. Two of the reservoirs are about 1,000 feet apart, but the pressure in each, as shown by the gauge, is the same."

I have mentioned thus far but one of the sources of loss of power in the use of steam, that of condensation. There is at least one other loss in the use of steam for power, and that without distant transmission, that is as great as the loss by condensation. This loss is found in comparing the possible steam plant, such as those that may be called the best in use, with the actual steam

plant, comprising boiler, steam pipe and engine, as it is all too frequently found in use. If one steam plant puts through the boiler only 12 or 14 pounds of water per horse power per hour, and another steam plant uses 50 or 60 pounds per horse-power per hour, or if one uses two pounds of coal per horse power per hour while the other uses 10 pounds, the latter costs in coal or in water more than 400 per cent. as much as the other, or realizes less than 25 per cent. as much power as the other. In practice, the extremes either of high or of low cost of power go beyond the figures that I have quoted. The examples of high cost are numerous and to be found everywhere, especially in small plants. While steam power is so widely employed, and employed in this wasteful way without attracting notice or remark as to the wastefulness of it, why should the public, that is glad to accept such service, try to howl down the use of compressed air on account of the waste and cost of it, when even with the added service of a long distance transmission it does not cost as much as steam? Air not only does what steam cannot possibly do in conveying power to considerable distances, or in holding itself ready for immediate use, no matter how suddenly or unexpectedly it may be called on, but it does it cheaper than steam actually does it.

Many air-compressing plants are now in operation (and responsible builders can produce them to meet any demand), that develop their power at the compressor upon two pounds of coal per horse-power per hour. The compressed air supplied by these compressors may be so employed as to realize 50 per cent. of the power developed at the compressor, which would be double the power realized from the fuel in the cheaper and commoner class of steam engines referred to above. This 50 per cent. of the original power could be realized from the compressed air without the device of reheating it at the time of use. By reheating the air 80 per cent. of the original power may be realized, which puts the air in economy on a par with steam in the, let us say, average stationary steam engine. The air would be badly and wastefully applied if but 25 per cent. of the original power at the compressor, or 25 per cent. of the possibilities of the fuel, were realized, as in the case of the too frequent small engine and boiler.

It may be that compressed air has a rather unfair advantage of steam here, but it is an actual and practical advantage all the same, and it should be appreciated and taken advantage of. If compressed air is employed for power transmission a central compressing plant is, or should be, employed where the fuel may be applied to the development of the power with the best economy, and after the compression the air may be transmitted with scarcely appreciable loss to considerable distances or distributed over large areas. Steam cannot be so transmitted, but, instead, if steam is used, small and wasteful boilers and engines must be scattered around at the places or near the places where the power is wanted.

Besides the actual economy of fuel in the employment of a first class central plant, which the use of compressed air makes possible, the saving of labor is another important item to be mentioned. If the air is employed, the labor of attendance is all accomplished by one or two men. If steam is used it means a multitude of small boilers and engines, with one or two men for each. The cost and care of distributing the fuel, and often also of conducting the water to a number of separate points instead of to one, is often an item of considerable importance. We might also allude to the comparative costs of repairs and of the attendant delays under the scattered steam plant system, as compared with the corresponding expenses with the central air-compressing plant, but the difference in this respect must be self-evident.

Compressed air, it need not be said, after what we have said, is cheaper than steam in many places, and should be used in many places where as yet it is not used. Not only is it cheaper than steam in so many cases of actual power transmission, but it will do so many things that steam cannot do that it would seem that every large manufacturing or mechanical establishment should have as part of its equipment a compressed air plant. Of the establishment of a general compressed air service in our large cities I cannot speak properly at the end of this article.

Apparatus for Testing Steam Gauges.

BY JAMES F. HOBART.

While it is possible to construct a steam gauge which will indicate pressure correctly for many years, if used under favorable conditions, it is not mechanically possible to make steam gauges which will remain accurate under the extreme variations of temperature and hard usage to which they are exposed. Especially is this true with the cheap and medium cost gauges made to supply the popular demand.

It is necessary, then, to use the cheap gauge and to test and maintain its accuracy by frequent inspection and adjustment—if necessary. In order to properly test and adjust a pressure gauge means must be provided whereby known pressures, ranging from zero to the maximum indicated by the gauge, can be conveniently and accurately applied.

The usual method of testing, as practiced by boiler inspectors, is to connect the gauge to be tested, and a gauge known to be correct, to the terminals of a screw pump. Pressure is then applied, and the gauge reading is compared with the test gauge over the entire index scale. In using this method it is necessary that the test gauge be correct, and to be sure of this it must be frequently compared with a master gauge which is used for no other purpose than for such comparison.

In turn the master gauge must receive its periodical comparison with some known standard, usually a column of mercury at 60 degrees temperature. When great accuracy of gauge adjustment is necessary, quite elaborate calculations must be made in order to compensate for the variation of density of the mercury column, by temperature, the variation due to gravity differences in different latitudes, elevations, etc., but with the exception of temperature, none of these possible sources of error need be taken into consideration when testing gauges by mercury column.

The engravings herewith presented show the engineer how to plan and construct for himself a gauge testing outfit somewhat similar (although differing somewhat in detail, especially in construction of the pump) to that used by the Hartford Steam Boiler Inspection and Insurance Company, in their home office at Hartford, Conn.

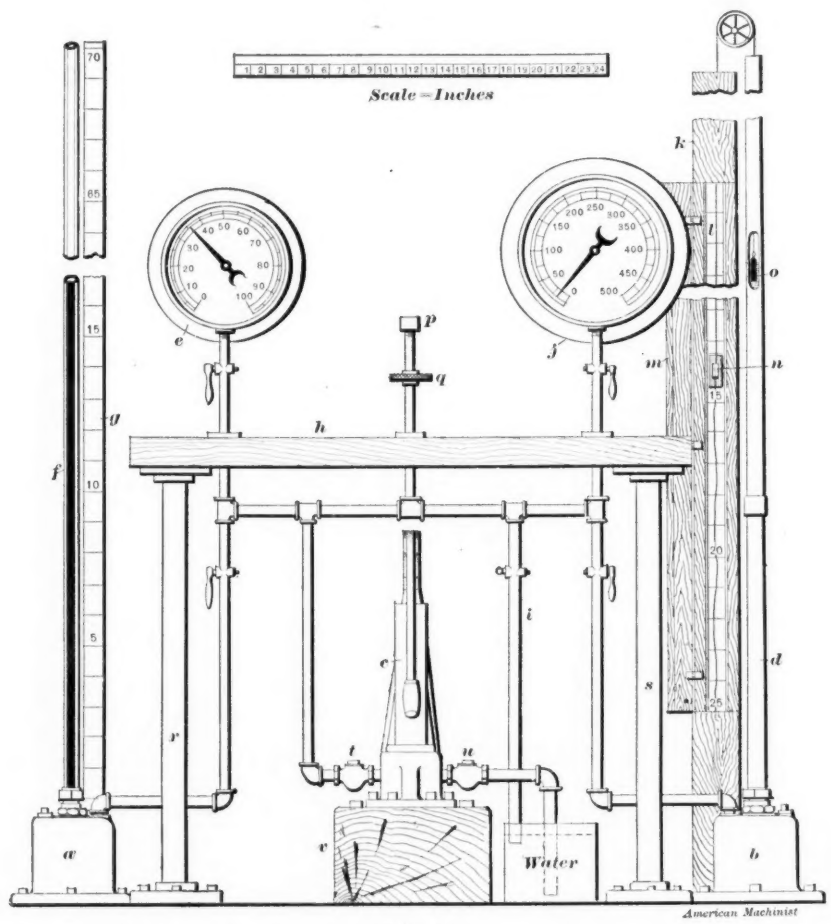


Fig. 1.

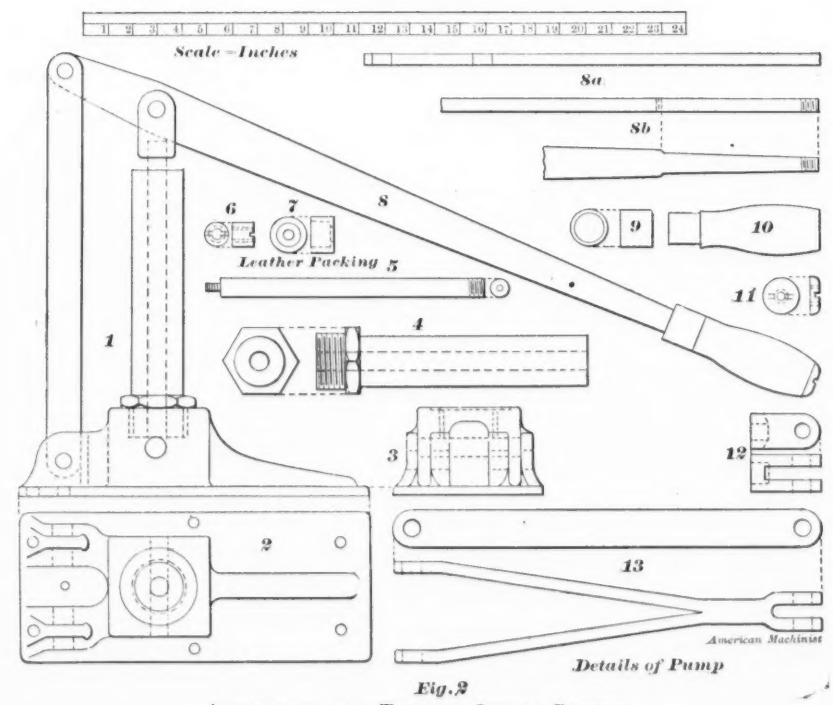


Fig. 2

APPARATUS FOR TESTING STEAM GAUGES.

Fig. 1 is a general view of the apparatus as arranged for testing gauges, both high and low pressure, up to 400 pounds by mercury column, and to 500 pounds by master gauge. In the engraving two mercury columns and two master gauges are shown, the column *f* runs up in a glass tube 12 feet long, and can be used for all pressures below 70 pounds per square inch. The column *d* runs up in an iron pipe. Ordinary gas, water or steam pipe will do, anything may be used which will stand a maximum pressure of 400 pounds per square inch; this column has a height of about 60 feet.

Owing to the impossibility of getting a direct reading from a mercury column varying between the limits of zero, and 60 feet in height, no glass tube is used for this column, the pipe being substituted as above mentioned, and the reading done by means of a cord passing over a pulley and attached to a float on the mercury. Iron pipe should be used, for mercury sometimes combines with brass when the conditions are just right.

The float *o* is made of iron; that metal will float on mercury. The index, on reading clip shown at *n*, is made of brass, german silver, or any other metal the constructor may fancy, or have on hand. The construction of these parts will be more clearly shown in the detail illustrations. The cord (and also the pulley at top of high column) is securely boxed up to protect it from dust, or meddlesome people. The cord boxing is shown at *k*, and a hinged front *m* swings open to allow the graduated scale *L* and clip *n* to be seen.

The mercury boxes *a* and *b* are of iron, cast in one piece and cored out as shown by 14 in details. The pump *c* is also fully described later, and is made of two castings, the barrel and base, of brass and iron respectively, though if the base is made of iron it must be bushed with brass where water comes in order to make sure that no rust or sediment collects in the pump.

For ease of construction this pump is made up with two ordinary check valves, *t* and *u* (Fig. 1), instead of having the valves usually supplied to pumps, with seats finished in the base. A good deal depends upon the tightness of valve *t*, and it has frequently to be ground to a fit. No unions or "rights and lefts" are shown in the drawing, and none are needed, as the three elbows at lower ends of risers have their horizontal openings each cut with a left-hand thread. The short horizontal pipes are, therefore, cut "right and left," so that the pump or the mercury boxes may be readily removed without disconnecting more than a single piece of pipe each.

The pipe *i* is an overflow, and by opening the valve in that pipe pressure is discharged from either or all of the gauges or columns. In comparing a gauge under "falling pressure" this valve is made use of, and being opened very slightly, the pressure falls very gradually, allowing time for a comparison of the gauges. A good deal of difference in the accuracy of gauges is frequently noted during rising and falling pressures. Some gauges will run up all right, but are "out" from two to twenty pounds in coming down. This is due usually to construction of the gauge; cheapness has much to do with it. Lost motion is responsible for much of the difference, especially in some forms of gauges where no hair spring is used.

The wooden shelf *h* (Fig. 1) is three feet long by twelve inches wide. Mahogany is good enough (and none too good) for a shelf. It is supported on the posts *r* and *s*, which are made of pieces of 1¼ inch pipe with flanges screwed on as shown. The master gauges *e* and *j* are attached as shown, and go with the "low" and "high"-pressure columns respectively (*f* and *d*). The gauge to be tested is screwed on at *p*. This pipe is shown capped in order to illustrate the

action of the two mercury columns under a pressure as shown. The milled disk q is simply for convenience in removing the gauge to be tested, and saves holding the pipe with a wrench, should pipe and gauge go into partnership.

The pump is raised as shown to prevent water from being left in pipes after check valve caps and mercury box plugs have been removed. This precaution is necessary in cold weather, when the machine is not likely to be used, and is in danger of freezing. If possible, however, the gauge testing machine should be so located that it will never be exposed to a freezing temperature. If it never goes below 60 degrees so much the better, and as the long pipe d can be run up through the floors of a building inside of the partitions, if necessary, it cannot be much trouble to arrange for a very even temperature.

The scales g and L are calculated for a temperature of 60° Fahr. Another scale should be provided graduated for a temperature of 80 degrees, as hereinafter described. With these two scales, known as "summer" and "winter" scales, the temperature variation can be closely adjusted and compensated.

The pump (see pump details, Fig. 2) has a three-quarter-inch plunger, three-inch stroke. The cylinder forms the guide. There is no stuffing box, hydraulic packing being used as shown at 7, Fig. 2. Molds for making this packing out of plain leather disks are shown at 17 and 19, Fig. 3. The pump base (1, 2, 3, Fig. 3) is cast in one piece, cored out as shown, and requires little machining to finish. The straightway water hole, the threaded hole and counterbore for barrel, and the pin hole being all the machine work required. The pump barrel must be finished all over, but the bore is perfectly straight and may be finished with a three-quarter-inch fluted reamer. Details of the barrel are plainly shown at 4.

The plunger is equally plain: a $\frac{3}{32}$ inch brass rod, $5\frac{1}{2}$ inches long, shouldered for half an inch to one-quarter inch at one end, and threaded at both, is shown at 5. The packing nut 6 is slotted for the screw driver or may be squared for a wrench if preferred. The hydraulic leather packing 7 has an outside diameter of $\frac{3}{4}$ inch. The internal length and diameter must just fit over the nut 6.

The pump lever 8 is 32 inches long, $\frac{1}{2}$ inch thick, as shown at 8 a, and one end (8 b) is tapered and threaded to receive the wooden, leather or vulcanite handle 10 and nut 11. If a wooden handle is used the ferrule 9 should be put on; this may be omitted with leather or vulcanite material. The lever and rod connection is shown at 12. If preferred, this may be cast whole with the plunger 5.

The yoke guide link 13 may be molded in brass, or forged from steel, the latter being preferable, two pieces of $1\frac{1}{2}$x$\frac{1}{2}$ inch mild steel, welded together at one end, can be quickly forged to shape, and makes a stronger and more desirable form of construction. This link must stand a tensile strain of 350 pounds, together with the friction of the pump which has not been taken into consideration. The section of metal around the hole at lower end of the link is not very heavy, and should be made of good material. The lugs between which the link is pinned (see end elevation at 3) were calculated for cast iron; if made in brass, they can be cut down a little and the section of 13 correspondingly increased.

The lever 8 is made 32 inches long, the short arm being 4 inches. Neglecting friction, the power necessary at handle will be 50 pounds to cause a pressure of 400 pounds on the plunger.

The mercury box, shown by a and b, Fig. 1, and in detail at 14, Fig. 3, is made of cast iron, cored out, and the only machine work on them is the reaming and tapping of two holes, and the drilling of one small hole in each box. The small hole is the water inlet and outlet. It is made small, not over $\frac{1}{32}$ inch in diameter, in order that there may not be a sudden discharge of the column of mercury in case the waste water valve were opened suddenly.

Given a 60-foot column of mercury, and the sustaining pressure is suddenly released by opening the half inch discharge valve, that column of mercury will drop with a velocity that is astonishing, to say the least. Suppose, after the column had got fairly started, say it had dropped 10 feet, the discharge valve was suddenly closed, what pressure would be put upon the mercury boxes before the falling column of mercury is brought to a standstill? The "professor" can figure out that pressure easy enough, but for safety just drill a $\frac{1}{16}$ inch hole as shown in the drawing, and there will be no trouble from —not water hammer, but mercury hammer.

The plugged hole at top of mercury box is for introducing the mercury; also for draining off water when danger of freezing is apprehended. The mercury boxes shown in Fig. 1 are about 4 inches (internal) diameter and 4 inches high. The boxes should be made large enough to hold sufficient mercury—and some to spare—to fill the tubes, and the boxes should also be strong enough to stand all the pressure that can be placed upon them, or in them.

The calculations for the mercury boxes are as follows: Cross-sectional area of $\frac{1}{2}$ inch tube, .19635 square inch. Call it 0.2 inch. A tube 12 feet high will therefore hold 28 8 cubic inches of mercury. One cubic inch of mercury at 60° Fahr. weighs .4907769 pound, therefore it will require 1 4 13 pounds to fill the tube. This quantity will fill a 4 inch cylinder to the depth of about 2.3 inches. Allowing enough mercury so that 33 per cent. shall remain in the box when the tube is full, requires 3.45 inches depth of mercury in the iron box. The extra mercury is for the purpose of catching whatever dirt, oxide, etc., there may be present in the mercury or its containing vessel. It must be remembered that all dirt which gets into mercury will *float on top* instead of settling to the bottom as when water is dealt with. For this reason extra mercury is desirable as a *dirt trap*.

The mercury box is therefore made 4 inches high to compensate for the tube extension 20, which extends almost to the bottom of the vessel. Both mercury boxes are shown of the same size in Fig. 1. This will answer when the 70 foot tube is of small diameter, but for $\frac{1}{2}$ inch internal diameter, a box 6 inches in diameter by 7.6 inches high (three-fourths full) will be required. This is calculated upon the basis of 163.2 cubic inches of mercury filling a $\frac{1}{2}$ inch tube 68 feet high, and answering to a pressure of 400 pounds per square inch.

The thickness of shell necessary to sustain 400 pounds per square inch must next be calculated. The process is the same as for steam boilers.

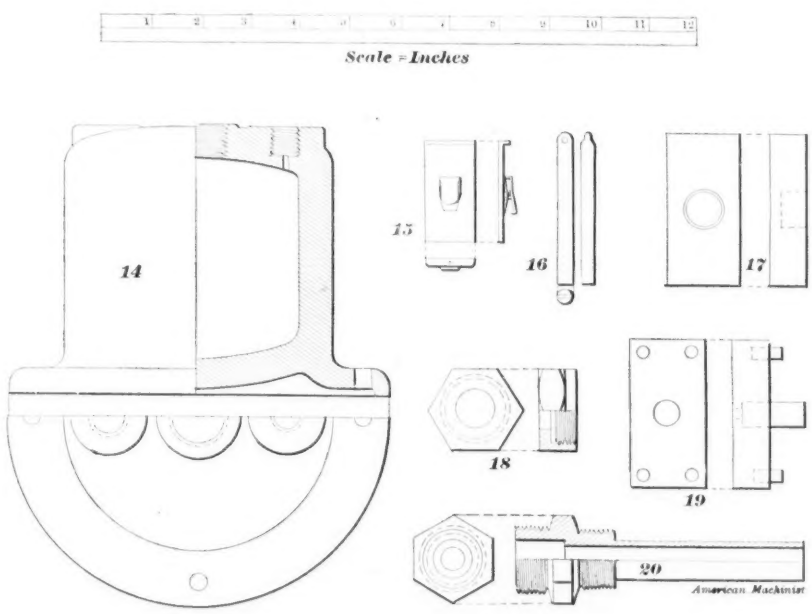
Let a = thickness of metal,
20,000 = tensile strength of cast-iron,
10 = factor of safety,
3 = radius of shell (internal).
Then:

$$a = \frac{400 \times 10 \times 3}{20{,}000} = .6 \text{ inch.}$$

The thickness of iron then should be pretty close to $\frac{5}{8}$ inch, and that thickness is used in the drawings. To enable the top and bottom heads to be made of about the same thickness, they are "bumped" up on a radius equal to the diameter of the cylindrical part of the mercury box. Probably the man who builds a mercury test column for his own use will not bother with "bumped up heads" or cast iron fancy mercury boxes. He will just cut off a section of wrought-iron pipe, screw on a couple of caps, tap in the tube and pipes, and call the job done. That is a good way. However, if a good looking job is desired, the drawing shows how to make it look well.

In Fig. 3, diagrams 18 and 20 show how the tube is connected to the mercury box. A bit of rubber packing is put into 18, and screwed down upon 20, around the glass tube, exactly as a water line glass is attached to the "combination" attachment on a steam boiler.

Diagrams 17 and 19 illustrate a form or mold for making the hydraulic (leather) packing used on the plunger. 17 is the mold, 19 the die. In using, a piece of wet leather is put over the hole in 17, and the die, 19, is forced with the leather around it, into the hole in 17, until the four distance pins come to a bearing. Screwing the whole business into a vise, or beneath the spindle of a drill press, is a good method of forming a packing. The leather left in the mold until dry will retain its shape for a long time. A simple punch and die may be used, but it does not give as good results as the apparatus illustrated.



Details of Mercury Box, Float, Target and Packing Mold
Fig. 3

APPARATUS FOR TESTING STEAM GAUGES.

Diagram 16 shows the float used in the high-pressure mercury tube; the float is made of iron, and looks like a little sash weight. As iron is only a little more than one-half as heavy as mercury, it will be seen that the float will readily stay on top of the liquid metal. Diagram 15 is the target or clip used on the cord attached to float. The material used for this has already been described; the little spring clip shown is for fastening the cord. It is nothing more or less than one of the clips that come with some kinds of suspenders for holding up the front of under-drawers. The clip is soldered to the target, or riveted, as the material used makes necessary.

As shown in Fig. 1, it is necessary to reset the target upon the cord every time the pressure is pumped up 25 pounds. Therefore, to test the high-pressure master gauge, pressure must be run up 25 pounds, then the target carefully set back to zero, 25 pounds more pumped up, and another setting made. These operations must be repeated until the required pressure is obtained.

Considerable calculation is necessary to lay off a scale for a mercury column. It is easy enough for low pressures, but up to 400 pounds it is considerable of a problem to make the graduated index tell the truth within one or two pounds. This is because of the temperature and compression errors.

As stated, a cubic inch of mercury at 60° Fahr. weighs .4907769 pound. In a tube one pound pressure of mercury would necessarily fill a section of the tube equal to 1 ÷ .4907769 = 2.037 inches high. The diameter of tube used makes no difference, therefore, the graduated scale must be marked off in divisions of 2.037 inches each, in order to represent pounds pressure per square inch.

Temperature makes so much difference that at different degrees 1 cubic inch of mercury weighs as follows:

— 40° — .5661 pound.
+ 32° — .4918 "
+ 60° — .4908 "
+ 212° — .4836 "

If mercury at 80° weighs .4877 pound per cubic inch, the graduations must be 2 05 inches apart per pound pressure, a difference of .03 inch. In 400 pounds this makes a difference of 12 inches, or between 5 and 6 pounds. The columns must then have two scales; one graduated at 2.03 inches per pound, another at 2 05 inches for 80° temperature. These scales are called "winter" and "summer" scales respectively.

The errors resulting from compression and capillary attraction are so small that they may be neglected.

For the instrument described above about 14.2 pounds of mercury will be required for the low-pressure tube, and 80 pounds for the high-pressure column, making nearly 100 pounds required.

Some glycerine should be placed on top of each column of mercury; say a body 2 inches high upon the column in the glass tube, and more than that on the tall column; this will protect the top of the column from oxidization. Two inches of glycerine will be just about enough to cover the interior of the tube, and apparently disappears by the time the mercury reaches the bottom of the tube, but will collect again after the mercury returns to the top.

In adjusting the height of zero on the graduated indexes, the tube p, Fig. 1, must be kept filled with water, as it is full when testing a gauge, and the hydrostatic pressure exerted by a column of water two and one-half feet high, represents over a pound pressure per square inch. Hence the necessity of filling the pipes with water before adjusting zero on the graduated scale, to the level of the mercury. Still another source of error is in the fall of mercury level in the boxes as height of column rises in the tubes.

Some of these errors balance each other, and the mathematical crank can have it for his job to figure out just how near they come to it. In spite of seeming variations, a good mercury column will work very close to correctness in gauge testing. It can be checked, if desired, by the addition of a dead weighted safety valve of exactly one square inch area of opening. A square hole surrounded by four knife edges, one inch long each, may be covered by a smooth plate, upon which the dead load is placed or suspended. Pressure greater than the dead weight cannot be pumped up with such an affair inserted in the pipe connections, but it is a wet, nasty contrivance, and is soon thrown into disuse, and dependence placed upon the master gauge, checked once in a while by comparison with the mercury columns.

New Engineering Hall at the University of Illinois.

November 15th was an important day at the University of Illinois, at Champaign. The occasion of the festivities was the inauguration of the recently appointed president, Dr. Andrew S. Draper, and the opening of the new Engineering Hall. The university as a whole as well as the new building was on exhibition. All buildings were open for inspection, and there were lavish decorations.

The exercises of inauguration were held

at 2 P. M. in Military Hall. Gov. John P. Altgeld presided and presented an address. Five minute speeches were made by Peter Junkersfeld, president of the senior class, for the students; Prof. S. W. Shattuck, for the faculty, and Hon. Chas. G Neely, class of '80, president of the Alumni Association. Dr. Thomas J. Burrill, dean of the faculty, presented the certificate of election, charter, keys, and so forth, to President Draper, who then gave the inaugural address. The programme of dedication was presented at 7.30 P. M. President Charles Kendall Adams, of the University of Wisconsin, and Gen. William Sooy Smith, of Chicago, gave the addresses of the occasion. The president's reception was held in Engineering Hall at 9 P. M. The railroads of the State gave reduced rates, and the numerous invitations sent out resulted in a large attendance.

Dr. Draper's experience as State Superintendent of Schools in New York, and in numerous other positions of equal responsibility, have given him a national reputation as an educator, and have eminently fitted him to be the head of this institution. He already has the confidence and hearty co-operation of every one connected with the university.

Engineering Hall is one of the largest and finest buildings devoted entirely to engineering education in this country, and is the handsomest building in the university group. It was built at a cost of $160,000, this amount being appropriated for the purpose by the Legislature of the State of Illinois. The building has a front of 200 feet, with wings at either end 76 feet deep, while the central portion extends back 140 feet. It is four stories in height. The first story is of Cleveland sandstone, and the remainder are of buff-pressed brick, with terra cotta trimmings. The roof is of slate, with large skylights. The Mill system of construction is employed throughout. Plate glass windows and Washington fir and polished oak, with other finishings in keeping, make the interior very attractive. Steam heat, mechanical ventilation, gas and electricity are used. The architect of the building was Mr. G. W. Bullard, of Tacoma, Washington, a graduate of the school of architecture of the University of Illinois.

In the planning of the building the greatest thought and care have been given to the arrangement of the rooms, and the furniture also has been designed to meet the requirements of modern engineering. Large space has been given to cabinet and wall cases, and ample provision has been made for filing pamphlets, drawings, photographs, models, specimens, and so forth.

The entire mechanical engineering department is under the direction of Prof. L. P. Breckenridge, and through his untiring efforts it is one of the best in the country. The shops and laboratories are in separate buildings, while the class rooms, offices, and so forth, have now been transferred from their old quarters in University Hall, which were long ago outgrown, to the third floor of Engineering Hall.

The drawing rooms, which occupy the east wing, are large, well lighted, and fitted with drawing tables, which will accommodate two students at a time. Each table is provided with four drawers, so that two sections may use the same tables; each table answering for four students. There are convenient wash bowls, towels, and tables for reference books, and adjoining the drawing room is a room fitted with cases especially designed for filing drawings, catalogues, and so forth. Reference books, planimeters, beam compasses, and so forth, are also kept in this room. The drawing-room equipment is complete, and the facilities for teaching machine design are unequalled.

The west wing is occupied by the offices and studies of the professors, commodious recitation and lecture rooms, a seminary room, and a cabinet room, in which latter are kept on exhibition all sorts of engineering specimens, pieces of ruptured boiler plate, sections of pump engines, valves and injectors, and framed photographs of machinery and drawings.

The mechanical engineering laboratory contains engines, boilers, pumps, condenser, and a large assortment of indicators, gauges, scales, thermometers, dynamometers, calorimeters, reducing machines, planimeters, and so forth. The mechanical engineering shops have large facilities for wood, foundry and pattern work, forge work and machine work.

The laboratory of applied mechanics has testing machines of 200,000, 100,000 and 10,000 pounds capacity, with a full line of apparatus for measuring extension, deflection, and so forth, and for work in hydraulics, has stand-pipe, tanks, weirs, orifices, gauges, meters, motors and pumps.

The electrical engineering laboratory is supplied with various types of direct and alternating current dynamos, storage batteries, measuring apparatus, arc and incandescent lamps, photometers and numerous other appliances.

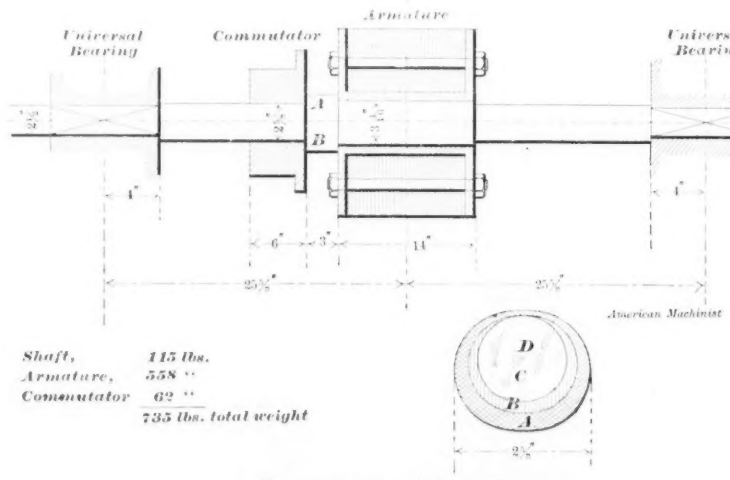
LETTERS FROM PRACTICAL MEN.

Failure of a Motor Shaft.

Editor American Machinist:

The accompanying sketch and detail weights refer to the armature shaft of an electric motor designed for intermittent service at speed from 0 to 725 R. P. M. The motor was subject to heavy jars and a great deal of vibration, and to partly relieve this strain it was supported on springs. All shoulders on the shaft were turned square, *i. e.*, no fillet in the corner.

After about six months' service or 60,000,000 revolutions of the shaft, it broke square



FAILURE OF A MOTOR SHAFT.

off at the shoulder A B, the fracture appearing as shown: The outer band A finely crystalline and partly rusted about $\frac{1}{8}$" wide at top and $\frac{3}{8}$" at bottom.

The second band B crystalline and bright, about $\frac{1}{8}$" wide at bottom to 0 at top.

The remaining space C was coarsely crystalline except at D, where it showed a few fibrous patches.

The shaft was made of ordinary machinery steel, such as is generally used in machine shops. Analysis of drillings taken from fracture is as follows: 0.41 carbon, 0.018 silicon, 0.205 phosphorus, 0.131 sulphur, 1.09 manganese. A second shaft broke after similar service and analysis was much better. A large steel firm recommended the following analysis for shafts subject to like stresses: 0 20 carbon, 0.05 phosphorus, 0.03 sulphur, 0 15 manganese, or even less.

Had the shoulders been filleted, the shaft would probably have lasted a little longer, and this would have been better practice.

The armature was made of two half hubs, with the sheet steel disks mounted thereon and held solidly together by six $\frac{3}{4}$" steel bolts. The hub was then bored out so as to fit on the shaft by driving. After taking everything apart the shaft showed plain evidence of having deflected where supported by the hub. The rated horse-power of this motor was about 40 at 500 R. P. M., the power being taken off both ends of shaft equally, so the torsional moment was small.

In my opinion, the shafts of all dynamos in general are designed too small to give the best results. Compare the shafts of a steam engine and a dynamo of similar capacities—notice the vast increase in size of the engine shaft.

You say I forget the inertia stresses, etc., so marked in the steam engine. There are stresses often very abnormal in dynamos, *i. e.*, the large mass of the armature or revolving field, as the case may be, is seldom in fair running balance, and in many cases the centrifugal forces amount to a surprising figure. The armature may not be mounted so as to revolve in the center of the field, thus giving a continuous increase of bending moment which may vary in intensity as regards the service performed by the dynamo; in lighting machines the load being practically constant, while for street railway service the load is apt to vary from 0 to 20 per cent. or more overload and very suddenly.

Again, the electrical "field" may be unbalanced, that is, the poles do not all exert the same force on the armature.

I think that the future practice will be towards larger shafts and balancing the revolving parts so as to run perfectly at the given speed, and the machine as a whole will be designed by the mechanical engineer, while the electrical engineer will have to do only with the electrical functions.

"FACTS."

Silicon Pig-iron.

Editor American Machinist:

Under the head "Silicon Pig iron" in your issue of October 11th, I am asked to explain what seems to be an exception to my statements, that in foundry practice by increasing the silicon in a foundry mixture the shrinkage is lowered, and *vice versa*. In other words, a record of the shrinkage of a half-inch test bar, will indicate whether silicon should be increased or diminished.

Mr. Mathes overlooks the fact that my remarks apply to a mixture of iron in a foundry only.

There is no given shrinkage for a given percentage of silicon. Different mixtures have different shrinkages though the silicon may be the same in each. Much less can we predict the shrinkage of a pig iron when we know its silicon.

The blast furnace conditions vary to such an extent that it is not possible to explain the cause of the shrinkage of a pig iron by its chemical analysis.

If a mixture of pig irons in a foundry gives us such castings as we require, all we have to do is to measure the shrinkage of a half-inch square test bar from such a mixture, and if at any time the shrinkage goes up, increase silicon, or if it goes below the standard, we can use more scrap. Up to 3.50 per cent. of silicon in a foundry mixture, it is correct to say that "the higher the silicon, the lower the shrinkage and chill." Now let us examine the case cited by Mr. Mathes.

No. of Sample.	Silicon in Pig iron.	Silicon in Test Bars.	Loss of Silicon.	Shrinkage ½" Test Bar.	Chill of ½" Test Bar.
1st	2.15	1.90	.25	.170	White.
2d.	2.54	2.10	.44	.155	.06
3d.	2.61	2.35	.26	.170	.18
4th.	4.17	3.75	.42	.175	.15

The silicon in his 4th sample is rather low for a silicon iron, while the 2d and 3d correspond to about No. 1 Foundry, and the 1st to No. 2 or No. 3 Foundry pig-iron.

The writer states that he uses "Keep's test." This test consists of a definite routine by which the peculiarities of an iron are made apparent to the eye. To use this test, every essential feature of the routine must be followed.

One essential in melting a pig-iron in a crucible, is to use a furnace about 30 inches deep, with a tight ashpit, with Connellsville coke, and a blast of 2¼ ounces pressure, and it is better to cover the crucible. None of these features have been followed by Mr. Mathes, and as a consequence his test bars are made from a highly oxidized iron, which is entirely different from the pig-iron. Very little silicon should have escaped, while he has lost from 11 to 21 per cent, or four or five times as much as could be lost in the worst cupola melting. So much depends upon conditions that I have discouraged the testing of pig-iron in a crucible.

If Mr. Mathes' foundry is running a uniform mixture, and if he is using a ½ inch test bar, and knows what the shrinkage is, the best way to test either of the irons mentioned is to substitute it in his mixture for the nearest similar iron. If in his mixture, silicon is less than 3 per cent., which is undoubtedly the case, if he uses enough of the 4th iron to increase the silicon in his mixture he will find that the shrinkage will decrease. If it should increase he would at once know that the 4th is not a desirable iron by which to add silicon to his mixture.

Detroit, Mich. W. J. KEEP.

Tests of Cast-iron.

Editor American Machinist:

In your issue of November 1st, Mr. West reviews the criticisms made on his paper by Mr. Cairns, and begins by showing a method of how to determine the expansion of cast-iron at the instant of solidification. This method is radically erroneous, because it does not do what was intended, but only shows the expansion of the pieces of metal abutting against the ends of the hot casting. (The Fig. 26, page 10, shows length of short arm of lever as 2 inches; Mr. West writes that it should have been ½ inch.) Hence, as block B was ⅝ inch thick, and block H omitted, while flask at H was ¾ inch thick, the metal in contact with hot test bar and expanding toward lever E was $\frac{5}{8} + \frac{3}{8} = 1.125$ inches. Now these parts of metal were heated to at least 650° Fahr., or a temperature which will burn wood, as every foundryman knows, and assuming metal and flask to heat 90 degrees in foundry before pouring, this makes elevation of temperature of 560° Fahr. As the coefficient of expansion by heat of cast iron (block B and flask being cast iron) is .0006 for every 100° Fahr., this will give linear motion at short end of lever $= 1.125 \times .0006 \times 5.6 = .00378$, or motion at long end of lever $= .00378 \times 156 = 0.589$ inch, or rather a little more than the total amount of motion which Mr. West has observed. Hence we see that without any contraction of the casting whatever, lever A would have moved fully as much as stated. Mr. West's statement that motion is less rather than more, if cast in open sand, is as it should be, as more heat would be dissipated, and less communicated to the abutting surfaces.

The assertion that chill and casting must remain in contact until cold enough to handle, is incorrect; for no increase in depth of chill occurs, after the casting and chill have become so cold that the contraction of former draws it away from the latter. At this instant they have both so low a temperature (and the same) that no further change occurs. If the casting were removed from the chill immediately after solidification, the bar would still be so hot that the depth of chill would be decreased materially. This latter does not occur in Keep's method. Mr. West should bear in mind that Keep's method is in successful, practical operation in many places at the present time, and that the chill test as

obtained thereby is entirely satisfactory. It has been so for several years.

Mr. West fails to understand that "exact indication" means only a relative amount, and by no means an "exact measurement." Mr. Cairns evidently uses the word "indication" in its true meaning. An "indication" is merely a relative quantity from which the actual quantity can be deduced. A pressure gauge may give an "exact indication" of load applied, but it does not actually carry or show the load itself. With this in mind, Mr. West's remarks on this point may be disregarded. However, Mr. Cairns' assertion that the depth of chill of a ½ inch square bar will "indicate exactly" the depth of chill in a roll of any diameter, is absolutely correct, for, having had some experience with the depth of chill of different sized rolls, and having determined how much a ½ inch square bar of same metal chills, he can with new metals tell exactly what depth of chill he may expect in various sized rolls, from the "exact indications" obtained from a ½ inch square bar. For example: If a roll 30 inches diameter chills 1¼ inches deep, and a ½ inch square bar shows 0.183 inch chill; then, if a new metal gives 0 183 inch chill in a ½ inch square bar it may be confidently expected that a 30 inch roll of this same metal will also show 1¼ inches depth of chill, if prepared precisely as first roll, and others larger or smaller a proportionate depth of chill. Hence in this case the measured depth of chill of ½ inch test bar gives "exact indication" of depth of chill. From this we can also determine the probable chill which would be found in a casting of any other size. With any other size of test bar the depth of chill would be different, but might be an equally "exact indication" of the natural chill of the metal.

The supposed new point claimed to have been discovered by Mr. West is an old established fact well known to every chilled wheel maker from the time the first chilled wheels were made. Mr. Keep particularly cautions users of his system to cast from the "middle of the heat," and at "always the same temperature," in order to insure uniform results. Let me ask Mr. West, "Why does every competent founder let a ladle cool off when *too hot*, or caution every one to use *extreme haste* when the cupola runs cold in making chill castings?" Has Mr. West ever worked in a chilled wheel foundry, and noticed with what extreme care the temperature of cupola and ladle is watched?

If a founder cannot regulate the heat of his metal with certainty he is incompetent, and certainly should not be employed in making test bars. It is admitted that temperature affects results in chill, and that it must be carefully regulated and controlled. Now, if repeated trials show that uniform results can be obtained from a given kind of metal then the method used to obtain these results is correct and satisfactory. If, therefore, Mr. West will take up the many tests published by Mr. Keep he will find almost invariable uniformity and identity of depth of chill in a given kind of iron and equal uniformity in each separate grade of iron.

Mr. West will also find that this uniformity is so invariable that depth of chill as obtained by Mr. Keep's method is entirely sufficient to determine the silicon in a given sample of iron.

Mr. West will also find that not only are these facts well-established, but, also, that the chill will decrease uniformly as the size of test bar increases. These matters are all of record and obtainable by those *who wish to see*.

Keep's methods and apparatus are in use in a great number of places at the present day, and as much or more in general machinery as in stove foundries. In the former there is no trouble in obtaining sound ½ inch bars any more than in the latter, and if certain foundries have not been able to do so, it is caused by their inexperience with this kind of work.

If it did not look like advertising I could give a long list of these various foundries.

Mr. Cairns' assertion, "the fact that the round bar is cast on end condemns it," is strongly combated by Mr. West, who says, 'I would say this is not borne out by my experience." Nevertheless, in a paper read before the Western Foundrymen's Association, October 24th, Mr. West makes the following statements in the third and fifth paragraphs after careful investigation and repeated trial, viz.:

"The writer's (West's) objects in presenting this series of tests are: First, to illustrate the fact that by *casting test bars on end*, we are using the best possible method to obtain the natural strength of an iron, hence more uniform results and satisfactory comparisons, that are not attainable by casting test bars flat."

And in the very next paragraph:

"It was first planned to have all these test bars cast on end, so as to afford the most favorable conditions to insure solid bars, etc., but in starting with car wheel mixtures, difficulty was found in getting the half inch square test bars to 'run,' and as there were other strong irons I desired tests from, *I changed the plan of casting* and had *all bars cast flat*, with an incline of two inches, the pouring gate being the high end."

Now, this definitive statement proves that the founders concerned had not sufficient experience, and were not able to do what others are doing daily as a mere matter of routine, with the same strong irons. In spite of this he goes on to say:

"While it is to be regretted that the bars tested for this paper were not cast on end, still the principles involved have not been sacrificed in any wise, and the object of the paper is served as well for the end desired."

Now, it was Mr. West's primary object either to prove what is stated above, or not to do it; if he really meant to prove his stand he should have adhered to his method; if he discarded this method "the object of his paper" was not what he claims, and the "end desired" does not appear on the surface, and all information given in it is radically defective, from its initial letter or figure to the end.

But let us look further into this paper, which next is supposed to prove:

"Second, to exhibit the desirability of using a round test bar as against the square bar in assisting to lessen erratic results, attain the iron's best strength, and afford the best means to make comparison between rough round and turned test bars."

Out of all the square test bars reported by Mr. West, 30.4 per cent. were defective, against 34 3 per cent. of defective round bars. This shows that square bars are more likely to be perfect than round bars.

This record also shows that this series of test bars was unfit for comparative test, as they were largely defective.

Now, taking the figures of transverse strength and reducing all to the same size bar, we find that the 1-inch square rough bars are uniformly stronger than their planed mates, and that the turned bars are also weaker than the rough cast bars, as shown by the following table:

DEDUCED AVERAGE STRENGTH OF BAR 1 SQ. IN. AREA.

	SQUARE BARS.		ROUND BARS.	
	1" sq. rough	1" sq. planed	1⅛" rough.	1⅛" turned.
Gun metal	3,296	3,056	3,686	3,194
Chill roll	2,000	....	2 913	3,063
Car wheel	2,320	...	2,687	2,595
Heavy machinery	2,495	....	2,696	2,399
Light machinery	1,681	..	1 859	1,527
Stove plate (?)	1 803	...	1,818	1,355
Sash weight (white iron)	1,373	...	1,440	....

Now, as it is a tolerably well established fact that rough bars are not as strong as finished bars, we must lay this discrepancy to the method of casting of these bars, and it is my opinion that casting a swell on the cylindrical bars, and then turning it off, is almost entirely the cause of this defect. It should be remarked that the above figures were obtained after rejecting those tests, which gave radically and palpably incorrect results. One point that is shown with greater clearness than any other in these results of tests is this, that the test pieces, as a whole, were so defective as to be entirely useless for comparative purposes.

Nevertheless, let us examine the proof offered by Mr. West, by which he assumes to establish his last proposition, which reads:

"Third, to prove the impracticability of using a half-inch square test bar to obtain any knowledge of the natural or relative strength of cast iron, or figure its value per square inch."

By examining his record, we will find that out of the 24 test pieces of ½ inch square section, only 7 defective, or only 29.2 per cent., as against 30 4 per cent defective in large square bars, and 34.4 per cent. defective in his round bars.

And calculating the strength of 1 inch square bars from the results he gives as those obtained from the small bars, we find the following loads required to break 1 inch square bars 12 inches long, viz.:

Gun metal ..... 3,262 lbs.
Chill roll ..... 1,957 or 2,159 lbs.
Car wheel ..... 2,411 lbs.
Heavy machinery ..... 3,093 lbs.
Light machinery ..... 1 649 or 3,682 lbs.
Stove plate (?) ..... 1,493 lbs.
Sash weight (white iron) ..... 1,469 lbs.

These tables clearly establish the fact that the small bars give better results than all of the larger square and round bars, because out of the twenty sets of averages of tests of large bars submitted, only seven show better results than those obtained by ½ inch square bars. The quality of material shown in the case of these seven "specialty castings" appeared better in ½ inch square bars in six cases out of the seven 1 inch square bars, in four cases out of seven 1⅛ inch rough round, and also in the 1⅛ inch turned bars.

A careful study of the figures given by Mr. West, and those deduced above will, no doubt, be found correct by those who are competent to judge, but I should like to say that the tests which were shown to give palpably incorrect results were thrown out; these are tests 14, 20, 21, 23, 24, 35, 37 51, 52, 69. Where two breaking loads are given, these were deduced from separate tests, which varied considerably.

All of these considerations and deductions prove to my mind very conclusively that Mr. West has not by any means established his propositions, much less disproved anything in Mr. Keep's methods, and hence it seems a waste of time and paper to refer to other points presented, except to call attention to Mr. West's novel and obviously incorrect method of determining strength per square inch from transverse test results.

GUS. C. HENNING.

The "Hyphen Corliss" Engine at Antwerp—Two Eccentrics on Corliss Engines.

Editor American Machinist:

I have been very much interested in the Hyphen Corliss valve motion shown by C. W. Crawford in your issue October 11th, page 11. So far I have been unable to understand the arrangement of the latches, and would be under obligations to you if you can make the matter a little plainer to me.

I don't see how the release is positive. We have just started a new tandem compound 22 inches x 40 inches x 48 inches Corliss engine, weight 310,000 pounds. She is equipped with two eccentrics, and the arrangement is all that W. E. Crane ever claimed for it.

We also put two eccentrics on a 20 inch by 42 inch and she develops 75 horse-power more since the change, before failing to cut off.

THOS. ELLIOTT,
Chief Engineer Atlanta Consolidated Street Railway Co.
Atlanta, Ga.

Editor American Machinist:

In connection with the letter of Mr. Elliott, who does not understand my sketch of a Corliss engine at the Antwerp Exposition, I have to explain that after examining the sketch as published in the AMERICAN MACHINIST of October 11th for a possible mistake, I find it correct in all essential respects. Perhaps I ought to have explained more fully that the cranks in front of the valve gear, to which the small reach rods are attached, are attached to and act as one with the latches, and the latches are thrown in and out by the positive motion derived from the main eccentric rod. It is to be understood that the T-shaped lever is mounted on and travels bodily with the vertical arm of the bell crank carrying both latches with it. It is possible the eccentric rod may be attached to the top of the wrist-plate, and I think a rocker arm is used in the usual way. It is evident the main eccentric must be placed on whichever side of the shaft will give the correct motion to the bell crank according as the engine runs under or over. The sketch was made from memory, the original one having been confiscated, and is not made to scale; hence too much value must not be put on the proportions. The ends of the latches are segments of a circle, and the hooks also approximately circular, having the pivot of the latch for a center. The latches and hooks are plated with steel and have a lap in gear of one inch, but this lap will vary with the point of cut-off. The guide block as shown is attached to the pin of one crank and serves for a slide for the long reach rod. If I have failed to explain this gear to the satisfaction of all it is none the less excellent. It works admirably.

Brazil, Ind. C. W. CRAWFORD.

Connections to Indicator.

Editor American Machinist:

In your issue of November 8th, Mr. Torrey calls attention to the constant used in my article on long and short connections, stating that the constant for a 10"x12" engine, at 312 revolutions per minute, would be 1.485, and not .745, as used by me. In endeavoring to make my article as concise as possible, I did not dwell upon details as I should have done had I known the discussion it would lead to. If, however, Mr. Torrey will look at the cut accompanying my article, he will see that with the pipe connection illustrated it was impossible for me to take cards from both ends of the cylinder. The mean effective pressures and horse powers given in my test were, therefore, those of the head end of the engine only. To use the constant 1.485, which Mr. Torrey uses, is to assume the mean effective pressure in the rod end the same as in the head end, which, while approximating the horse power of the engine, is not that recorded in the test. There are so many causes for variations in indicator cards that, as Mr. Torrey points out, the conditions should be carefully studied to make sure that observed differences are purely those due to alteration of connecting pipes.

EDWARD J. WILLIS.

Feed and Lubrication in that Remarkable Job of Milling.

In our issue of the 8th inst. we gave an account of a remarkable job of milling being done at the shops of the Pratt & Whitney Co., in Hartford. When this appeared we received inquiries as to the direction of the feed, and other particulars connected with the job, and in reply to our letter of inquiry, have been favored with the following letter from the Pratt & Whitney Co.:

Editor American Machinist—DEAR SIR: We duly received your favor of 9th inst, and beg to say in reply, that the No 7 double head milling machine was run a short time in the "old way," in which the cutters ran against the feed, but this took so much power that the "new way" was tried, in which the cutters ran with the feed, and less power was required, and the work was more quickly done. The cutters were lubricated with soda water, the pump delivering about three gallons per minute. The cutters and the plates were but slightly warm under this treatment.

As an experiment, we substituted oil for 24 hours, using the same quantity per minute as of soda water, and the cutters and plates grew warm and warmer as time went on, until it was impossible to handle them without gloves. The lubricant was then changed to soda water, the cutters being still warm when the change was completed; and it was found on finishing the first plate that the cutters were comparatively cool. When two plates had been milled, the temperature had gone back to that found when this lubricant was used only.

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☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

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☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

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The Desire of a Tool Builder.

A tool builder whose business—or at least a large share of it—is in the line of fitting up factories with special machinery and tools for the economical production of small machines and appliances in large numbers, was saying the other day that a considerable portion of his time was taken up in trying to form conclusions as to what was to be the next new development in manufacturing of that class.

Years ago, guns and other small arms had claimed his attention; then it was sewing machines; then typewriters; then cash registers, and now bicycles. One after the other these various articles had been first constructed experimentally in his establishment, and then as they became regular articles of manufacture, he had in some cases taken contracts to manufacture them in large numbers or had sold the equipment for their manufacture elsewhere.

Certain standard machine tools had, of course, been used in all the various branches of work, and the only changes in them had been such improvements as could be devised from time to time, but there was a considerable proportion of the work which was special, a large class of machines and tools used in typewriter manufacturing, for instance, being entirely useless on bicycle work and *vice versa*.

As a tool builder, he was, of course, glad of this, for his business depended largely upon his ability to produce machines and tools adapted to new conditions—conditions for which the older machines and tools were not adapted; and if he only had the power of looking into the future a little further to see what was coming, and thus be enabled to prepare for it, he would be somewhat happier—or less miserable.

We frequently see references to the importance and necessity for business men looking into the future as far as possible, but a machinery manufacturer has all the incentive to do this that other business men have, besides some others that are peculiar to his business, and that ordinary business men do not have.

The Report of the U. S. Strike Commission.

We have received an advance copy of the report of the U. S. Strike Commission, appointed to investigate and report upon the Pullman strike, and have carefully read it. We advise every one of our readers who is at all interested in public questions to do the same, if possible, and we especially caution them against forming an opinion about the report from newspaper extracts and comments upon it, many of which we believe to be grossly unfair and misrepresenting. The fact is that too many newspapers during the time the trouble was going on lost their heads—seemed to think that the foundations of government were about to be overthrown, and that they could prevent this by simply frothing at the mouth, and misrepresenting things. Some of them seem to think now that in order to appear consistent they must villify the commission and misrepresent its report.

As a matter of fact, the report seems to us to be a very calm and impartial one, and we wish that every citizen could read it entire, and form his own opinion upon it.

In the report both sides to the controversy are criticised. It is declared that the demands of Pullman employes for a restoration of the wages of 1893 were unjustified by the conditions of business at the time the demand was made. The acceptance as members of a railroad organization, of men employed in building and repairing cars, and the subsequent taking up by that organization of a dispute between these new members and their employers are condemned. It is stated that the evidence shows that the officers of the American Railway Union were opposed to the strike in the beginning, and that though they advised against violence, and endeavored to prevent it (most of this being done, according to the report, by hoodlums and mobs composed of people who had no connection with railroads or organizations), the organization was yet, morally, largely responsible for this violence, because it was carrying on an unwarranted contest, which in the cases of some roads and their employes was in violation of previously made agreements between the companies and their men.

On the other hand, it is declared that the Pullman employes had good and sufficient reason for dissatisfaction. The paternal system in vogue there is condemned, and the arbitrary and inconsiderate treatment of employes is criticised. Especially is the course of the company's officers with respect to efforts at conciliation, arbitration, etc., condemned, particularly when these efforts were made by The Civic Federation of Chicago, "composed of eminent citizens in all kinds of business, and from all grades of respectable society."

The portion of the report which in some respects will have most interest for the general public and the student of civic questions, is that in which the nature and objects of the General Managers' Association are set forth. This, it seems, is an association of 24 railroads entering Chicago. It is declared to be an unincorporated association, having no sanction in law, and exercising powers which would never be granted by the people to any corporation. It is shown by the testimony of its own members that it has virtually constituted a gigantic combination of railroad companies, controlling not only the wages of employes, but also other matters, such as rates, treatment of patrons, etc., and is in short "an illustration of the persistent and shrewdly devised plans of corporations to over-reach their limitations and to usurp indirectly powers and rights not contemplated in their charters and not obtainable from the people or their legislators."

We have given only the most prominent points covered by the report, and have tried to do this fairly. We are in no way responsible for the opinions expressed in it. They are simply matters of official record and are of interest to every American. We hope our readers will avoid forming conclusions regarding it made up from reports and criticisms inspired by obviously unfair motives, either a desire to make it appear that in all respects and everywhere the men were right, or, on the other hand, that Pullman, Wickes, and the General Managers' Association were justified in all they did, the latter effort palpably inspired in many cases by railroad passes in the pockets rather than by good judgment and a desire to be candid, temperate and fair.

There are a number of ways of appropriating to one's self the results of others' labor which, while they are not usually classed as stealing outright, yet in principle (or in lack of it) are the same thing. When an editor boldly appropriates our editorial articles and publishes them, verbatim, as his own, we know how to classify the acts of such a bad man; but when, instead of doing this, he takes our editorials and, using our ideas one after the other in their order, appropriates them for his own, simply clothing them in different, and, sometimes, we feel bound to say, much finer language, this, it seems to us, partakes of all the elements of unjustifiable appropriation without the extenuating feature of bravery—of boldly facing the consequences of wrong-doing.

Ideas (as our readers long ago discovered, probably) are not so plentiful with us that we can take pleasure in seeing them thus appropriated, and when two of our editorial articles are thus treated in a single issue of a contemporary (*The Age of Steel*) we feel moved to observe that the proprieties are somewhat violated. For a year or more past we have been noticing similar practices upon the part of our appreciative and discriminating contemporary, else we would still longer hold our peace.

Several times we have commented on the fact that railroad companies who incited their men to fight for the possession of crossings, or to prevent crossings being laid, were setting an example of lawlessness and anarchy, and should be dealt with accordingly. Something of this kind was done not long ago in Massachusetts, where some employes of the Old Colony road were sentenced to jail for being implicated in the Abington riots in August, 1893. They had tried to prevent an electric railroad from making a crossing. There are workingmen, railroad officials, college students, and others who seem to need to be taught that laws must be enforced and good order preserved, and that to make exceptions to this is dangerous, and in the end disastrous.

Death of Chas. G. Chase.

Charles G. Chase, president of the Mason Regulator Company, died in Brookline, Mass., November 8th, at the age of 67 years. Besides Mr. Chase's interests in the company spoken of, he had been extensively engaged in mercantile pursuits, and he enjoyed the confidence and highest regard of all who knew him.

QUESTIONS AND ANSWERS.

Questions of general interest relating to subjects discussed in our columns will receive attention in this department. The writer's name and address should always accompany the question. Neither correct initials nor location will be published when there is a request to that effect. If questions are enclosed with a business communication, they should be written on a separate sheet.

(536) C. V. A., Baltimore, Md., writes: Please let me know who is the publisher of Peak's Naval Architecture. *A.*—This is one of Weale's series, published by John Weale, London, England. It can be obtained from any dealer in technical works in this country.

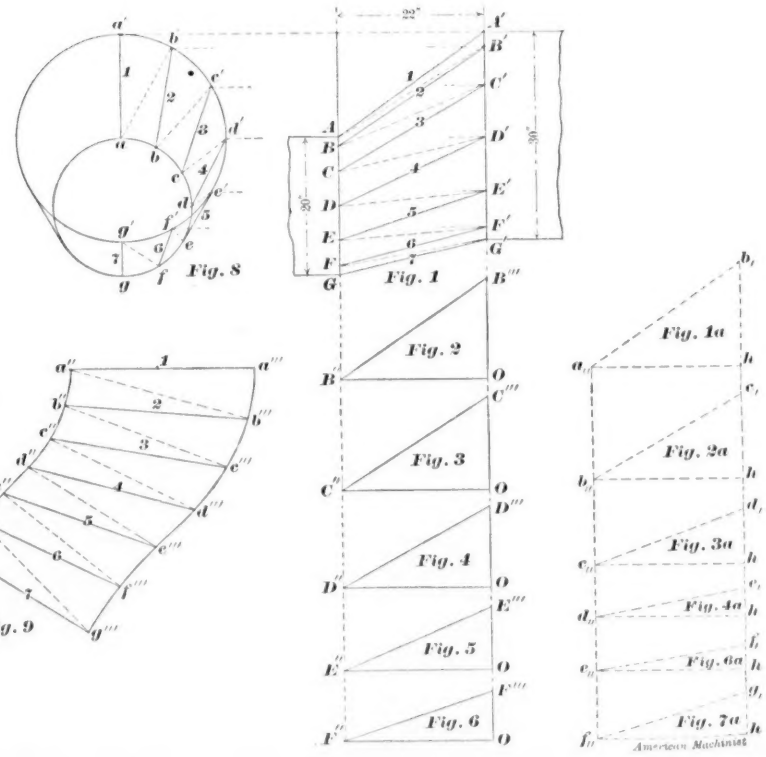
(537) C. H., Brooklyn, N. Y., writes: Kindly give the address of the publishers of Reed's Engineers' Hand book, and where it can be obtained. *A.*—The publishers are Thomas Reed & Co, 184 High street, West Sunderland, England. It can be obtained from any dealer in technical works in this country.

(538) J. J. A., Cannon Falls, Minn., writes: Please inform me how to lay out the iron for a smoke-stack made of different gauges of iron. I have always had trouble when changing from one gauge to another. Please give hints to go by. *A.*—We presume you refer to cylindrical smoke stacks made out of inside and outside courses. The rivet holes should be laid out by templates, or regulators, as these are frequently called in boiler shops. These regulators are generally made of wood about 2 to 2½ inches wide, and about $\frac{3}{16}$ inch thick. Along the center line a row of rivet holes are laid off, and these holes are then transferred to the sheet by means of a marker whose diameter fits the holes nicely. To lay out the regulator for the circumferential seam, say, for the outside course, establish the position of the two extreme holes, the distance between the centers of these holes must be equal to the circumference of a circle whose diameter is equal to the outside diameter of this course, minus the thickness of iron. If the thickness of the iron is ¼ inch, and the outside diameter of the course is 15 inches, then the distance between the centers of the extreme holes must be $(15 - \frac{1}{4}) \times 3.1416 = 46.33$ inches. Draw a straight line between these centers, and divide this distance into as many equal parts as there are rivets, the number and diameter of rivets in the seam will depend on the thickness of the iron. Through each point of division a hole is bored to suit the diameter of the marker. The positions of the holes are then transferred to the iron by laying the regulator in the proper position, care being taken to have the row of holes perpendicular to the center line of the vertical seam. For the inner course a separate regulator will have to be made. The distance between its extreme holes must be equal to the circumference of a circle whose diameter is equal to the inner diameter of the outer course, minus the thickness of the metal. If the outer diameter of the outside course is 15 inches, and the thickness of the iron is ¼ inch, then the inner diameter of this course will be $15 - \frac{1}{4} = 14\frac{1}{2}$ inches. If the thickness of the iron for the inner course is also ¼ inch, then the distance between the extreme holes on its regulator will be $(14\frac{1}{2} - \frac{1}{4}) \times 3.1416 = 44.76$ inches. The distance between the extreme holes is then divided into the same number of equal parts as there are on the first regulator. If

these regulators have been correctly laid out and correctly placed on the sheet for transferring the holes you will have no difficulty in making the rivet holes meet.

(539) E. A., Chicago, Ill., writes: Kindly reprint as much as you can of the article of "What to Study and How to Study," which appeared in one of your issues, and which I did not get. I desire to study in the evenings, and desire to get the books named in the article. *A.*—This article appeared in our issue of February 19, 1891, of which the following are extracts: "It is not an easy matter to lay out a course of study to unknown persons; what may suit one may not suit another, and to recommend books is very perplexing, there are so many good books to select from that space will not permit us to name them all. It is therefore only just to say that the books which we shall mention are by no means the only good ones, they are simply a few of those which we have used, and with which we are familiar. One of the principal duties of the mechanic is to shape material to some form which is usually indicated on a drawing. It is therefore of the greatest importance that he should be able to read a drawing. Before much progress can be made in the science of drawing the principles of elementary geometry should be mastered, and for this purpose 'Elementary Geometry,' school edition, by Prof. E. Olney (1), may be used. For the study of geometry the student should provide himself with a drawing board, T and set squares, and drawing instruments, and work out all solutions of the problems, which should finally be inked in. Neatness and accuracy should be cultivated from the start, which will tend to stimulate the interest in the study of this important branch of mathematics. Elementary geometry treats on the development of all laws relating to space and rules by which portions of spaces can be best compared with each other. The position of geometrical magnitudes are determined by referring them to two planes, called the planes of projections. For an explanation of these methods we must take up descriptive geometry, which is but a development of those general methods by which lines, surfaces and solids may be presented to the mind by means of drawings. This study is by no means a difficult one to a person whose reasoning power has been developed, but to the beginner it may prove to be a stumbling block. It will therefore be better to defer this study until others have been mastered. For designing, a knowledge of algebra is necessary. There are many good books treating on this subject, but since we have mentioned Prof. E. Olney's geometry, it will probably be as well to get the 'Complete Algebra,' by same author (2). It is also important that mechanics should know something of the laws and physical properties of matter, and those phenomena that depend on physical changes. For this study beginners may use 'Elements of Natural Philosophy,' by E. M. Avery (3). The science of mechanics treats of motion and equilibrium of bodies caused by the application of force. Since there are three conditions of matter—solid, liquid and gaseous—it is convenient to divide the general subject into three branches: 1st, the mechanics of solids; 2d, the mechanics of liquids, called hydrostatics; 3d, the mechanics of gases, called pneumatics. These branches are of great importance to practical men, and they should not be satisfied with the knowledge obtained from an elementary work on natural philosophy. It is therefore advisable to procure other books, which treat on mechanics. 'Theoretical Mechanics,' by J. E. Taylor (4), and the 'Principles of Elementary Mechanics,' by Prof. De Volson Wood (5), should be studied. After these studies, 'Descriptive Geometry,' by C. Davies, should be taken up (5). Then should follow the 'Strength of Materials,' by Sir John Anderson (6) The books we have mentioned so far are comparatively cheap, plainly written, and are not only well adapted to the wants of mechanics, but are useful to those who wish to become engineers. After the student has become thoroughly familiar with these subjects he will have no difficulty in understanding more advanced works on engineering. 'Mechanics of Machinery,' by A. B. W. Kennedy (7); 'Text-book on Steam and the Steam Engine,' by Prof. A. Jamieson (8); 'Manual of the Marine Engine,' by A. E. Seaton (9); 'Indicator Practice, and Steam Engine Economy,' by F. F. Hemenway (10); 'Treatise on Steam Boilers,' by R. Wilson (11); 'Practical Treatise on High-pressure Steam Boilers,' by W. M. Barr (12), and 'Elements of Machine Design,' by Prof. W. C. Unwin (13), are useful books to have. For the more advanced course of study we recommend 'Mechanics of Materials and of Beams, Columns and Shafts,' by Prof. M. Merriman (14); 'Hydraulics,' 'Roofs and Bridges,' 'Graphic Statics,' all by the same author (15); and 'Theory of the Construction of Bridges and Roofs,' by Prof. De Volson Wood (16). It is not necessary that the whole geometry should be studied before any other subject is taken up. After the first part of geometry has been mastered, algebra may be commenced, and the two branches studied conjointly, until the introduction and the beginning of Part I., say, up to page 27, in the algebra we have mentioned, have been studied and are thoroughly understood. At this stage the student will perceive the advantages of geometry and algebra, he will be able to read and understand some of the simpler works on engineering, which, otherwise, may be to him sealed books. At this stage it may be a kind of relief to take up natural philosophy. The books marked (1) (2) (3) are published by Sheldon & Co., New York and Chicago; (4) (6), by Longmans Green & Co., New York; (5), by A. S. Barnes & Co., New York; (7), by Macmillan & Co., New York; (8), by Charles Griffin & Co., London, England; (9), by D. Van Nostrand Company, New York; (11), by Crosby, Lockwood & Co., London, England; (12), by John Brothers, Indianapolis; (13), by D. Appleton & Co., New York. All the other works are published by John Wiley & Sons, New York. All these books may also be obtained from any dealer in technical works."

(540) E. M., Providence, R. I., writes: Kindly explain how to lay out the tapered course between two pipes, as shown in Fig. 1. I have not seen this explained in any book. *A.*—Draw an end view of the tapered course, as shown in Fig. 8. Divide the small semi-circumference $a\ d\ g$ into six equal parts—a greater number will give more accurate results; also divide the large semi-circumference $a'\ d'\ g'$ into the same number of equal parts. Join the points of division b and b', c and c', etc., by straight lines; these represent elements of the surface. The next step will be to show these lines in Fig. 1; this is done by projecting or squaring the points b', c', etc., over to the line $A'\ G'$, and thus obtain the points $B\ C$, etc. Also square the points b, c, etc., over to the line $A\ G$ and thus obtain the points B, C, etc.; and then join the points B and B', C and C', etc., by straight lines, which will represent the lines $b\ b'$, $c\ c'$, etc., in Fig. 8. Of all these lines in Fig. 1, we see the correct lengths of two only, namely, $A\ A'$ and $G\ G'$. For laying out the sheet, we must also know the correct lengths of the lines $B\ B'$, $C\ C'$, etc. These lengths are found as shown in Figs. 2, 3, 4, 5 and 6, thus: To find the correct length of the line $B\ B'$, draw the line $B''\ O$, in Fig. 2, and make its length equal to the distance between the lines $A\ G$ and $A'\ G'$, that is, in this example, 22 inches. At the extremity O draw a perpendicular line $O\ B'''$ and make its length equal to $b\ b'$, in Fig. 8. Join the points B' and B''' by a straight line; this line will show the correct length of $B\ B'$, in Fig. 1, or, of course, the correct length of $b\ b'$, in Fig. 8. In a similar way, we obtain the correct lengths of $C\ C'$, $D\ D'$, etc.; we simply lay off lines $C''\ O$, $D''\ O$, $E''\ O$ and $F''\ O$, as shown in Figs. 3, 4, 5 and 6; the length of each one of these lines must be equal to 22 inches, and on the extremities O we erect perpendiculars $O\ C'''$, $O\ D'''$, $O\ E'''$ and $O\ F'''$, whose lengths are respectively equal to $c\ c'$, $d\ d'$, $e\ e'$ and $f\ f'$, in Fig. 8. Then join the points C''' and C'', D''' and D'', etc., by straight lines, which will show the correct lengths of $C\ C'$, $D\ D'$, etc., in Fig. 1. For the development of the sheet, we also need the auxiliary lines $a\ b'$, $b\ c'$, $c\ d'$, etc., drawn from one of the extremities of the lines $a\ a'$, $b\ b'$, $c\ c'$ to the opposite extremity of the next line, as indicated in Fig. 8 by the dotted lines; these are also shown dotted in Fig. 1. The correct length of these auxiliary lines must also be found, and the method for finding these lengths is precisely like the method of finding the lengths $B'\ B'''$, $C'''\ C'''$, etc.; namely, in Figs. 1*a*, 2*a*, 3*a*, etc., set off the horizontal distances $a_{,,}\ h$, $b_{,,}\ h$, $c_{,,}\ h$, etc., equal to 22 inches, and on h erect perpendiculars $h\ b_{,}$, $h\ c_{,}$, $h\ d_{,}$, the lengths of which must be respectively equal to $a\ b'$, $b\ c'$, $c\ d'$, etc., in Fig. 8, join the points $a_{,,}$ and $b_{,}$, $b_{,,}$ and $c_{,}$, $c_{,,}$ and $d_{,}$, etc., by straight lines, which will be the correct lengths of the auxiliary lines. We have now all the data required for the development of the sheet as shown in Fig. 9. Draw the horizontal line $a''\ a'''$ and make its length equal to $A\ A'$ in Fig 1. From a'' as a center and with a radius equal to $a_{,,}\ b_{,}$ (Fig. 1 *a*) describe a short arc, from a''' as a center and with a radius equal to $a'\ b'$ in Fig 8 describe another arc cutting the former in the point b'''. From b''' as a center and with a radius equal to $B'\ B'''$ (Fig. 2) describe an arc, and from a'' as a center and with a radius equal to $a\ b$ in Fig. 8, describe another arc cutting the former one in the point b'', join b'' and b''' by a straight line $b''\ b'''$, which will be the correct location of the element $b\ b'$ in the development, and the extremities b'' and b''' will be points in the bounding curves. In a similar way the element $c''\ c'''$ in Fig. 9 is located, thus: From the point b'' as a center and a radius equal to $b_{,,}\ c_{,}$ (Fig. 2 *a*) describe an arc, and from b''' as a center and a radius equal to $b'\ c'$ (Fig. 8) describe another arc, cutting the former one in the point c'''. From c''' as a center and a radius equal to $C'''\ C'''$ (Fig. 3) describe an arc, and from b'' as a center and with a radius equal to $b\ c$ (Fig. 8) describe an arc cutting the former in the point c''; join c'' and c''' by a straight line which will be the correct location in the development of the element $c\ c'$. In precisely the same way all the other elements are located in the development and curves drawn through their extremities a''', b''', c''', etc., and a'', b'', c'', etc. The last line $g''\ g'''$ is equal to $G\ G'$ in Fig. 1. Fig. 9 is the development of one-half of the sheet, the other half is an exact duplicate. Since we have divided the semi-circumferences in Fig. 8 into equal parts the distances $a''\ b''$, $b''\ c''$, $c''\ d''$, etc., must also be equal and the same remarks apply to the distances $a'''\ b'''$, $b'''\ c'''$, $c'''\ d'''$, etc.; all the former are, of course, equal to $a\ b$ in Fig. 8, and the latter distances equal to $a'\ b'$ in Fig. 8. The same letters in the different views represent one and the same point, so that the whole construction can be readily followed. The lengthy description we have given may seem to make the method a very complicated one, but this is not the case; if once the principles are understood, the method will appear to be very simple. It consists simply of locating in the development elements of the surface by means of auxiliary lines, and then joining the extremities of the elements in the development by curves. For practical work the lines $B\ B'$, $C\ C'$, etc., need not be drawn, all we need Fig. 1 for is to get the length $A\ A'$ and $G\ G'$. Figs. 2, 3, 4, etc., can all be combined into one figure, and Figs. 1 *a*, 2 *a*, etc., can also be combined in one figure. The reason for showing separate figures was to avoid confusion. This method, generally called the method of triangulation, is applicable to a great variety of work.



BUSINESS SPECIALS

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"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram, also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price, $2 post paid. Published by John Wiley & Sons, 53 East Tenth street, New York.

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Second Meeting of the Society of Naval Architects and Marine Engineers.

The Second General Meeting of the Society of Naval Architects and Marine Engineers took place in New York City on the 15th and 16th inst., in the auditorium of the American Society of Mechanical Engineers, 12 West Thirty-first street.

Exceedingly interesting and valuable papers were read before a very large attendance. The officers elected for the ensuing year are:

President—Clement A. Griscom, Esq. *Vice-Presidents.*—Charles H. Cramp, Esq; Philip Hichborn, U. S. N.; Chas. H. Loring, U. S. N. (retired); Richard W. Meade, U. S. N.; George W. Melville, U. S. N.; George W. Quintard, Esq; Irving M. Scott, Esq.; Francis A. Walker, Esq.; Wm. H. Webb, Esq; Theodore D. Wilson, U. S. N. *Members and Associate Members of Council.*—Francis T. Bowles, U. S. N.; French E. Chadwick, U. S. N.; Frank L. Fernald, U. S. N.; H. Taylor Gause, Esq.; Nathaniel G. Herreshoff, Esq.; Thomas W. Hyde, Esq.; William H. Jaques, Esq; John C. Kafer, U. S. N. (retired); Frank B. King, Esq.; Frank E. Kirby, Esq; Jacob W. Miller, Esq.; Lewis Nixon, Esq.; Calvin B. Orcutt, Esq; John F. Pankhurst, Esq.; Harrington Putnam, Esq.; William T. Sampson, U. S. N.; Horace See, Esq.; Edwin A. Stevens, Esq.; E. Platt Stratton, Esq; Stevenson Taylor, Esq.; George E. Weed, Esq.; Frank W. Wheeler, Esq. *Executive Committee*—Francis T. Bowles, U. S. N., chairman; Washington L. Capps, U. S. N., *ex-officio;* H. Taylor Gause, Esq; Clement A. Griscom, Esq., *ex officio;* Lewis Nixon, Esq.; Harrington Putnam, Esq.; Edwin A. Stevens, Esq. *Secretary and Treasurer.*—Washington L. Capps, U. S. N.

The report of Secretary shows the

society to be in a very flourishing condition, and it now has a membership of 450.

The address of President C. A. Griscom was exceedingly interesting. Among other things he said:

"In a brief introductory address it is not my intention or desire to burden you with any statistics of shipbuilding progress during the past year; indeed, it would be a mournful recital, for this branch of industry has suffered severely from the general depression that has prevailed throughout our land, but, from papers announced to be read, you will doubtless derive some very definite ideas as to what we need for the development of our naval and mercantile marine.

"The increasing love for yachts and yachting, and especially the very great interest taken in the recent international yacht races, are sure indications of our natural love of the sea, and with the growth of this spirit must surely come the natural ambition to see the American flag flying upon American merchantmen in every harbor on the globe.

"The naval battle which has recently occurred in the war between Japan and China is of surpassing interest, not only to naval men and members of this society, but also to our citizens in general, as establishing the value and necessity of an adequate naval force.

"The information at present at hand, though sufficient to arouse some controversy as to the value of types of ships, cannot be regarded as sufficient to form an opinion, or even to lead to serious question as to the relative advantages of battle ships and cruisers.

"It will be necessary to have accurate information in regard to more than one battle, before the confidence of naval men is in the least shaken in the greatly preponderating efficiency of armed vessels

"There are points of the highest and most essential value, however, brought out by the battle of the Yalu River. Those which most impress me are, the immediate strategical and actual results, due to the fact that Japan *possessed* a large and capable modern fleet, and that it was thoroughly prepared for actual service, not only with munitions of war, but also with skillful and well trained officers and men.

"These are the lessons which can be brought home to our countrymen. It should be understood that a modern naval force, with all its multitude of equipment, arms, munitions and accessories, cannot be produced on the spur of the moment, but is the product of naval architects, steel makers, and a host of others whose skill can only be obtained by experience.

"It must not be overlooked that the personal element in warfare, as in peace, is an all powerful one, sometimes predominating, sometimes secondary, but always of the greatest importance, and, therefore, an adequate navy is necessary, not only for the actual representation of power and force, but also to secure to our officers and men those superior nautical aptitudes only to be obtained by such continued experience at sea as made heroes of Hull, Decatur and Farragut.

"The full development of a *naval force*, however, is not possible unless the growth of the *merchant marine* has kept pace with the naval development. My quotation of the words of Sir Nathaniel Barnaby in my address to you last year:

"'No nation could maintain an efficient navy without a prosperous commercial marine to support it,' has still the force of an axiom.

"And it should not be overlooked that in time of war the conversion of fast mail steamers into armed cruisers is generally recognized among all maritime nations as a most formidable means of offense or defense for any country so fortunate as to possess them.

"Moreover, to provide the expansion of *naval personnel*, rendered necessary in time of war, there must be a well-trained *merchant* marine to draw upon, and those nations which have not encouraged shipbuilding and shipowning in times of peace must inevitably suffer from their short-sighted and narrow policy when confronted with a powerful hostile fleet.

"A technical society of this kind has no *raison d'etre* if there are no ships to build, and, if its labors in a purely technical field result in re-awakening general interest in the development of our great maritime resources, there will be little doubt that the inception and growth of a society of this kind is a national blessing."

The first paper was read by Richard W. Meade, Rear-Admiral U. S. N., giving some suggestions of professional experience in connection with the naval construction of the last ten years—1884–1894.

In this paper the Rear-Admiral gave his experience when he suggested iron frames in place of those made of timber, and among other things, he says:

"Even so far back as the building of the 'Wampanoag' and 'Madawaska' (1863 to 1865), I urged on my friend, Mr. Delano, one of the ablest of our shipwrights of that day, the folly of building the frames of those vessels of timber instead of iron. I represented to him that, with the double diagonals and the great mass of strapping and bracing in those abnormally long and rather remarkable vessels, there had been put a considerable part of the weight of an iron frame; but the only reply my friend would vouchsafe to what he regarded, doubtless, as the moonstruck madness of a non-professional, was one quite characteristic of the intolerance of these able but extremely narrow minded shipbuilders of the 'old school': 'You are a boy and don't know what you are talking about; iron frames, indeed!' I still believe that had those two vessels been constructed of iron instead of wood, they would be in existence to-day and doing efficient service.

"When one considers what we had in 1884, and what we have in 1894, it is not at all remarkable that European nations respect our naval progress. To them it is ominous as an evidence of what we can do when we make up our minds to build in earnest. To the requirements exacted by our naval authorities from the manufacturers of steel in 1885, we owe the marked advance we have made in the guns, armor and projectiles of to-day. This advance in the manufacture of steel in the United States is due primarily to the navy. I think this is now admitted, but if proof be needed I could say that, in 1885–1886, I commanded the 'Dolphin,' the first of the new ships, and the steel industry of this country was so imperfect that the contractors were unable to furnish a reliable steel shaft for that small vessel, and I believe she is still going with the iron shaft that was in her in December, 1885."

Relating to the coast defense, so far as the navy is concerned, the Rear Admiral says:

"If I had my way, not a single cruiser beyond those already designed, building and built, should be added to the navy, until at least twenty battle-ships, one hundred torpedo boats, and a suitable number of rams were in readiness for active service.

"But while the naval construction of the past decade is, in the main, satisfactory, it is not, I think, entirely satisfactory to the majority of experienced commanders. The vessels that seem to be the least satisfactory to the practical men of our profession are the 'Columbia' and 'Minneapolis,' and the 'Detroit' class; the 'Cincinnati' class, also, in a less degree, except for coast defense.

"And they are unsatisfactory for these reasons, the smaller vessels cannot cruise in time of war except in home waters; and as to the larger ones, such as the 'Columbia,' it is feared that vessels like the 'Majestic' and 'Teutonic,' for instance, may laugh at our three-screw racers, which cannot cross the ocean at the same speed these commercial greyhounds maintain year in and year out. Moreover, as to the question of fighting, I doubt very much the superiority of the 'Columbia' over the American liner 'New York,' the latter suitably armed, as she would be in the service of the Government, while, as to coal capacity, the 'New York' or 'Paris,' of the American line, are by far the superiors of the 'Minneapolis' and 'Columbia,' and already many thinking men believe that the third screw is nothing more than a very expensive experiment, which we will not be in a hurry to repeat."

After this, considerable space in the paper is taken up by a list of the integral parts of an efficient fleet for modern warfare. Among the concluding remarks he says: "And now to a broader question than all else. It is the duty of every patriotic American to assist in rebuilding and rehabilitating the American merchant marine, its increase to be side by side with the growth of the navy. Indeed, for my part, I am even more anxious to see our mercantile prosperity on the seas restored to what it was in the early fifties than to build cruisers for the navy, for, without a mercantile marine, we cannot have a sufficient reserve of good seamen; and without good seamen and their officers, ships and guns are of little use."

This paper caused an animated discussion; among those who took part was Commodore George W. Melville, Engineer-in Chief, U. S. Navy, who said:

"I have carefully read the paper by Admiral Meade, and find that he has fallen into an error which is not at all uncommon amongst people who have made a hurried comparison between such ships as the 'Minneapolis' and the Atlantic express steamers, like the 'Campania.' Nobody will deny that the 'Minneapolis' would be a much better ship for us, if she carried as much coal as the 'Campania' does, but it requires very little investigation to show that this is a physical impossibility. From the description of the machinery of the 'Campania,' recently published in the *Engineer*, of London, I find that her horse-power is about 28 000, and that her coal consumption is 600 tons a day; although I have seen it elsewhere stated that it is as much as 646 tons. However, assuming that it is 600 tons, and that her bunker capacity is not greatly in excess of what would be necessary to make a run in very heavy weather, she should carry at least 4,000 tons of coal. If we gave the 'Minneapolis' this much, the coal and machinery would take about 80 per cent. of the displacement of the ship, leaving less than 1,500 tons for hull, battery and equipment. It is needless to say that the 'Minneapolis' could not carry such an amount of coal. I have made a fairly reliable estimate of the weight of the 'Campania's' machinery; and, making all possible allowance for her, I find that it cannot be less than 3,000 tons, and that it probably is nearer 3,500 tons. This, with the amount of coal which she must carry in order to maintain her speed on her special service, make the two factors of coal and machinery as large as the total displacement of the 'Minneapolis.'

"I have prepared a table showing the relative sizes of the two vessels, their speed and bunker capacity, and weight of machinery, from which it will be seen that the 'Minneapolis' has about 23 per cent. of her displacement in coal, and the 'Campania' 22 per cent, assuming that she carries only 4 000 tons.

"Were it possible to build a vessel of the displacement of the 'Minneapolis' to run across the Atlantic at her speed, it is safe to say that the owners of the large trans-atlantic liners would not be building vessels more than twice as large to do the same work. The fact of the matter is that when you want high speed and great endurance with it, you must build big ships, much bigger ones than we have ever built for the navy. One other point connected with this is that of space occupied by the machinery. In the 'Minneapolis' the boilers occupy 1½ cubic feet of space per I. H. P.; in the 'Campania' they occupy nearly 2 cubic feet, or practically 50 per cent. more than they do in the "Minneapolis"; in the engine room there is about the same or a greater ratio of space and power.

"While I am not prepared to controvert Admiral Meade's statement as to the desirability of building such ships as the 'Minneapolis,' it cannot be denied that we have produced a remarkable vessel in point of speed and endurance, on a comparatively small displacement.

	"Minneapolis,"	"Campania."
Length between perp.	411 6	600
Beam	58.19	65
Draught	22.5	27
Displacement	7,350	18,000
I. H. P.	21,000	28,000
Speed	23	23
Coal in Bunkers	1,700	4,000
Per cent. of displacement.	23 coal.	23 coal.
Weight of machinery	2,000 t.	3,000 t.*

* Approximate, but less than actual.

After the discussion, the following papers were read:

"The Use of Small Models for the Determination of Curves of Stability," by Mon. L. E Bertin.

"Some Obstacles to Shipbuilding and Owning in This Country," by Geo. W. Dickie, Esq, Naval Architect.

"Electricity on Shipboard; Its Present Position and Future Development," by S Dana Greene, late Ensign, U. S. Navy.

"Cellulose and Its Application to War Ships," by Mon. Em. Cheneau.

"The United States Triple screw Cruisers 'Columbia' and 'Minneapolis,'" by Commodore George W. Melville, Engineer-in Chief, U. S. Navy.

This paper was listened to with great interest by a large audience. In regard to these vessels, the Commodore said:

"Although I had the honor of recommending the use of triple screws on these vessels, it is hardly necessary to tell this society that the use of triple screws was not a novelty, and that any credit in the matter arises simply from their use for machinery of much greater power than had previously been attempted, and for persisting in the design against the advice of some of my best friends in the profession, who believed it too much of an experiment.

"When I was asked to design machinery of about 21,000 I. H. P. for the 'Columbia,' there were a number of questions which came up for consideration. One was that of securing economy at moderate speeds when full speed was so high, and another was that of the shafting. When the design was under consideration, no steel shaft had yet been made in this country for the transmission of as great a power as 10,000 horses, and, while I had every confidence in my friend, John Fritz, and the Bethlehem Iron Company, I felt that it would be safer to adopt a design which would give us smaller shafting. The alternative to triple screws was twin screws, either with one very large engine, or two smaller ones on each shaft. The former meant large parts of the machinery all through, and the latter great multiplication of parts.

"When the 'Columbia' and the 'Minneapolis' were designed, we hoped to secure a speed of about 22 knots for the maximum I. H P. of 21,000, and while some enthusiasts predicted higher speeds, those of us who were more conservative felt that 22 knots was about all that we could reasonably expect. The news that the 'Columbia' had made 22.8 knots was, therefore, both gratifying and astonishing when the official report showed that it had been made on only about 18,500 I. H. P.

"When the 'Columbia' was designed there was a general belief that the race from the side screws would cause the center screw to work in water having a sternward motion, and it was the intention to give it about 10 per cent. more pitch than the side screws. However, before the 'Columbia' was tried, it was learned that the trials of the 'Kaiserin Augusta,' the German triple screw vessel, had shown that, if given such an increase of pitch, the center screw could not work up to the designed number of revolutions. When the 'Columbia' was tried, all the screws were given the same pitch, 21 feet 6 inches, but the center screw ran some five revolutions per minute slower than the side screws, and the mean effective pressure of its engine reduced to the low pressure cylinder was nearly three pounds more than that of one of the side screws. In the case of the

'Minneapolis,' the pitch of the center screw was set at 6 inches less than that of the side screws (21 feet 6 inches, and 22 feet), and ran about one revolution faster than they with an aggregate mean effective pressure greater by three pounds, and nearly 700 more I. H. P. Now, clearly, this can only be explained by assuming that the forward wake exerts a very strong pressure, and, as we have undoubted facts of the high speed and moderate horse power, the action of the screw cannot have interfered with the stream line action enough to increase the resistance of the ship.

"Thus, it seems to me that the most reasonable explanation of the increased economy of propulsion is that, in an unusual degree, the center screw, which occupies the same position as the propeller in single screw vessels, profits by the forward motion of the frictional wake, and this without interfering with the stream line motion sufficiently to increase the vessel's resistance.

"As has already been stated, it was not anticipated, when triple screws were adopted, that their use would give any increase of economy of propulsion, their adoption being mainly due to constructive reasons, and incidentally to secure economy at cruising speeds. It appears now, however, that this method does give an increase of economy at maximum powers. It would seem, therefore, that for very high speed ships this arrangement would commend itself, and, if it were not dangerous to prophesy, I should be prepared to anticipate the adoption of triple screws for all the new 'flyers' that enter for the transatlantic race.

"A few words more and I shall finish. It would be a natural supposition that, having built the two fastest cruisers in the world for our navy, every naval officer would rejoice at their possession and be proud of them. I regret to learn, however, that we are in a mild way repeating the experience of the 'Wampanoag,' which, as some of you may remember, was declared a failure by a board of naval officers, although she was far and away the fastest vessel in the world, being several knots faster than anything else afloat, and, as some believe, an important factor in the settlement of the Alabama claims at Geneva. Now, the cry is raised that, although we have the fastest ships, they can't carry coal enough to go across the ocean at full speed. In fact, some say that we don't want such fast ships, and others echoing the jealous wails of a few of our transatlantic friends, have actually talked about the ships being failures.

"It seems very hard to satisfy our critics. Before we began the building of our new navy, it was constantly hurled in our teeth that we were behind the times; that we couldn't build as good ships as they did abroad, and so on to the end of the chapter. Now, we have beaten our foreign friends, and we are told that fast ships are useless."

We regret that we cannot give this valuable paper in full. At the conclusion of its presentation the meeting was adjourned to the next day, when the following papers were read:

"A Dynamic Steam Engine Indicator Tester," by Prof. C. H. Peabody, and Asst. Prof. E. F. Miller.

"Experience Gained With Our New Steel Ships As Regards Care and Preservation," by Philip Hichborn, Chief Constructor, U. S. Navy.

"The Present Status of Face hardened Armor," by Captain W. T. Sampson, U. S. Navy, Chief of Bureau of Ordnance.

"Hydraulic Power for Warships," by Albert W. Stahl, Naval Constructor, U S. Navy.

"Yachts in England and America," by Lewis Nixon, Esq., Naval Architect, Philadelphia, Pa.

"Steamer and Tow Barge Efficiency and Classification of Lake Vessels," by Jos. R. Oldham, Naval Architect, Cleveland, Ohio.

"Notes on Launching," by William J. Baxter, Naval Constructor, U. S. Navy.

"Accessibility and Circulation of Water Tube Boilers," by L. D. Davis, Esq., M. E., Erie, Pa.

"Recent Light Draught Gunboats of The U. S. Navy," by J. J. Woodward, Naval Constructor, U. S. Navy.

The principal office of the society is now 12 West Thirty-first street, New York; and the office of the secretary is at 1710 F street, N. W., Washington, D C.

An Indexing Device for Cutting Gears on a Milling Machine.

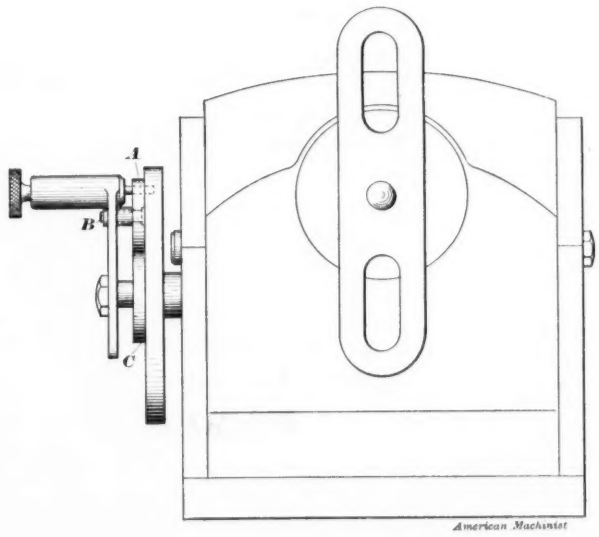
BY WILLIAM H STEDMAN.

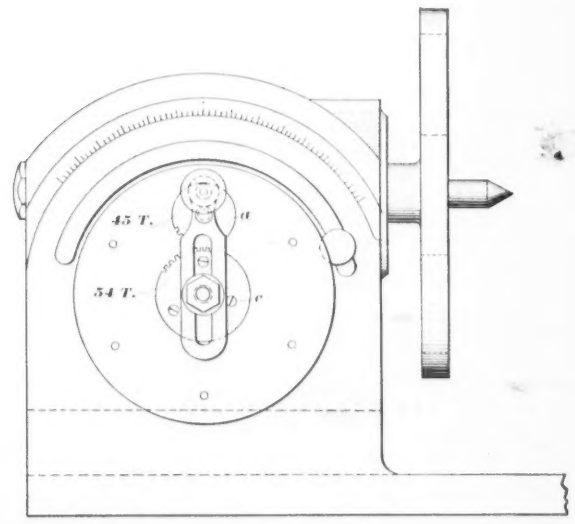
Some time ago the writer had several hundred gears to cut two inches diameter 24 pitch. The shop being without a regular gear cutter, the job was done on a milling machine using an ordinary dividing head of the worm wheel variety. The index pin was used in the 48-row on the dial, and the sector set to allow the pin to take 40 holes, the five sixths of a revolution of the crank at each spacing giving the required 48 divisions of the work.

After quite a number of the blanks had been spoiled by the operator failing to index properly, the sector was removed and the device shown in the illustration put in its place, with the result that no more blanks were lost, and the spacing was done much quicker. The gear *A* has a hole near its outer edge through which the index pin must pass to enter a hole in the dial, and is free to revolve on the stud *B*, which is secured to the crank. This gear meshes with a stationary gear *C*, which is fastened to the dial. The gears are proportioned, so that while the crank moves through five-sixths of a revolution, the gear *A* revolves once on its axis.

In operation, the index pin is withdrawn from the dial and gear, and the crank revolved until the pin again passes through the hole in the gear into the dial. This mechanism may be used without the regular dial, but in this case it was used simply as a counter, so to speak, and was not depended on at all to divide the work, and therefore did not require to be accurately made.

In many cases a pair of gears will answer for several numbers of teeth; as, for example, with the pair shown two holes in gear *A* would cut 96 teeth, four holes 192, etc., and the extra holes may be covered when cutting the smaller numbers. Although originally designed to prevent the loss of work, it has been found that by its use the number of gears cut per day was materially increased.





INDEXING DEVICE FOR CUTTING GEARS.

A Call for a National Conference of Manufacturers.

The following call has been issued and explains itself. It is addressed to the manufacturers of the United States, and is as follows:

"Gentlemen—The Manufacturers' Association of Cincinnati and Hamilton County, Ohio, desiring to promote the prosperity of the manufacturing interests of the entire country, and appreciating the importance of concerted action, hereby respectfully invite your organization to be represented at a

"CONFERENCE OF MANUFACTURERS,

"Which will be held in the city of Cincinnati, on the 22d day of January, 1895, for the purpose of general interchange of views, looking to the formation of a National Association of Manufacturers, which shall embrace among its purposes:

"First—The advocacy of carefully considered legislation, to encourage manufacturing industries of all classes throughout the country.

"Second—The discussion of ways and means whereby trade relations between the United States and foreign countries may be developed and extended.

"Third—The establishment in South American capitals and other desirable points of permanent expositions for the display of American products.

"Fourth—Such other topics as may be agreed upon by the Convention.

"It is desired that this Convention shall be non political, non-partisan and non sectional.

"The invitation hereby extended is without limit as to number of attendants, and is cordially extended not only to accredited delegates from organized exchanges, representing manufacturing interests, but to any individual manufacturer who may have the promotion of the general good by organized efforts sufficiently at heart to be willing to meet with us.

"The favor of reply, not later than December 1st, prox., accompanied by suggestions, is respectfully requested.

"W. T. PERKINS,
"FREDERICK PENTLARGE,
"B. W. CAMPBELL,
"H. C. YEISER,
"CHAS. F. THOMPSON,

"Committee from the Manufacturers' Association of Cincinnati and Hamilton Co., Ohio."

A Modern Instance.

In our issue of October 18th we mentioned the instance of an improvement of a steam plant under the direction of a competent engineer, which improvement resulted in a large building being both heated and lighted on a smaller consumption of coal than had formerly been required for heating alone.

Since this publication we have received evidence that there are numbers of mechanics who are interested in such a case, and they want particulars regarding it. We give some of these below.

The building in question is The Bingham House; a well-known hotel in Philadelphia. It had been heated by steam and lighted by incandescent lamps, the latter by contract with a local company. Dr. W. A. Drysdale, a consulting electrical engineer of Philadelphia, was called in, and, under his direction, the improvements were made which resulted in the economy referred to. As we said before, the heating system was improved and arranged to use exhaust steam from the engines.

The changes were made in the fall of 1893, and two 50 K. W. generators were put in, driven by Ball & Wood horizontal center-crank engines, direct coupled, *i. e.*, with the armatures on the crank-shafts. One of the engines is right hand, the other left, and they stand facing each other in a very restricted space in the basement of the building. No jar or vibration is felt in the building, and, as there are no belts, the engines run almost absolutely without noise. We have before us a letter from The Bingham House Company in which they state that their expectations of economy, based on statements of Dr. Drysdale, have been more than realized, and that within 15 months the plant will pay for itself.

Accompanying and forming part of the letter referred to is the following statement:

Fuel, January, 1893	$1,040 00	
Edison's bills for light	989 74	$2,029 74
Fuel and light, January, 1894	682 00	
Extra wages	115 00	
Depreciation, including oil, etc	85 00	
Lamps purchased	38 00	920 00
Saving		$1,109 74
Fuel, February, 1893	$865 50	
Edison's bills for light	1,084 49	1,949 99
Fuel and light, February, 1894	822 25	
Extra wages	115 00	
Depreciation, including oil, etc	85 00	
Lamps purchased	38 00	1,060 25
Saving		$889 74

This shows the saving effected by the new plant during two winter months, and, as will be seen, is entirely fair, though it does not bear out the company's statement in regard to the number of months in which the plant will pay for itself if the statement is taken as meaning 15 successive calendar months, because the showing of savings would not be so good in the months when little or no heat is required. But, this aside, the showing is sufficiently good to indicate something of the extent of the field for the installation of similar plants and reflects great credit upon all who have been concerned in its installation.

Launch of the "St. Louis."

The American Line twin-screw passenger and mail steamer "St. Louis," built by Wm. Cramp & Sons Ship and Engine Building Co, of Philadelphia, Pa., was successfully launched on the 12th inst. This vessel and her sister ship, the "St. Paul," will soon take their places on the line of the International Navigation Company, of which C. A Griscom is president. These vessels will be the largest and most powerful steamships built in the Western Hemisphere, and with two exceptions, the largest and most powerful in the world; they are built from American plans, and of American material.

The construction of the "St. Louis" was commenced in July, 1893, and up to this time something more than six thousand tons of steel have been worked up in her hull. The construction of the "St. Paul" is progressing rapidly, and is only about three months behind her sister ship. The principal dimensions of these two steamers are: Length over all, 554 feet 2 inches; length between perpendiculars, 535 feet 8 inches; extreme breadth, 63 feet; depth molded, 42 feet; number of decks, 5; depth of water bottom, 4 feet; number of principal watertight compartments, 17.

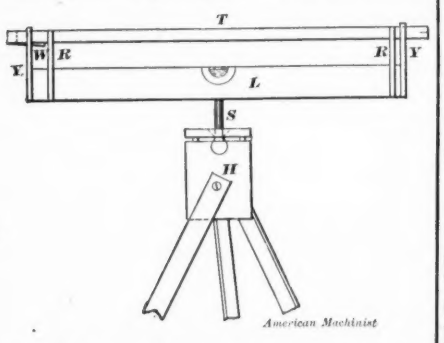
The engines are of the quadruple expansion type, with cylinders 36, 50, 71 and 100 inches diameter, stroke 60 inches; they are designed to give not less than 20,000 horsepower. There are six steel double ended boilers, each 20 feet long and 15 feet 7½ inches in diameter, designed for working pressure of 200 pounds per square inch. The total grate surface is about 830 square feet, and the total heating surface about 30,000 square feet. Besides the main engine there will be 49 auxiliary engines in each ship.

The total number of persons each ship can carry is as follows: First cabin, 320; second cabin, 200; steerage, 850; crew, stewards, etc., 400; total, 1,770.

More Backwoods Engineering.

Mr. Hobart's "Backwoods Hydraulic Engineering," in the issue of November 1st, calls to mind a somewhat simpler problem propounded to me, which was, I think, solved by correspondingly simpler means.

A farmer neighbor, a "handy man," had two lines of tile drain to lay across one of his fields, some 100 rods in all, and thinking that "plumbing a square" was too tedious



a job, he appealed to me to suggest some more expeditious way. Recourse to the village machinist (?) gave us our limitations, but it suggested some features as well.

As with Mr. Hobart's combination plane-table and level, a carpenter's level was the foundation of our instrument; but not having a camera tripod, we had to construct it "from the ground up." The sketch will give an idea of the affair.

The tripod was a triangular prism of hardwood with the legs secured by long wood screws so as not to turn too easily. In the top was bored a hole for the ball and socket level support, it being bottomed by a leather disk from the farmer's boot top. A triangular hardwood cap with a conical socket and secured by three more screws, held the ball spindle—this latter a metamorphosed bolt—in place with the requisite amount of pressure. This bolt and the sighting tube were the "machinist's" only contribution.

The bolt was screwed firmly into a hole in the bottom of the level. A much more convenient way would have been to allow the level to revolve on the spindle; but this, unless the hole were exactly perpendicular to the plane indicated by the bubble, would have necessitated re leveling whenever the sighting tube was turned, would have required a smooth, round and preferably conical spindle; and to bore the hole in the required perpendicular was practically an impossibility. We avoided too frequent leveling by setting the instrument on the line of the drain.

The Ys were wooden rests tacked to the ends of the level, and the clips were heavy rubber bands passed around both tube and level. By making the Y at the eye-piece slightly shorter than the other, a wedge at *W* gave opportunity for adjustment.

The "telescope" was a piece of copper tubing—tin would, of course, have answered as well—fortunately, longer than the level body; the eye-piece was a peep hole drilled in a wooden plug, and the cross hairs were horse hairs, attached in filed notches with sealing wax.

I taught the farmer to subdivide his feet into tenths by means of diverging lines and parallels, and with the outfit which cost even less in time and material than did Mr. Hobart's plane table, but with corresponding limitations, we had the satisfaction of profiling the drain line of 100 rods, and checking within .3 of a foot.

The sketch I append will be self-explanatory. NOVICE.

The persistency with which the starboard eccentric strap of the "Ericsson" breaks whenever the engines are pushed, would seem to indicate that there was something wrong with the design somewhere.

Owing to frequent complaints from America of swindling operations by alleged patent lawyers in London, one such firm has been broken up, and the U. S. Embassy warns American inventors to be cautious in dealing with people in London offering to take out English patents.

A strange accident happened in Elkhart, Ind., where a knitting-mill was undermined by muskrats and was wrecked.

MANUFACTURES

A $15,000 electric light system will be established at Etna, Pa.

The Sanquoit Silk-mill at Scranton, Pa., will be extensively enlarged.

The cotton-mill at Springvale, Me., will be extensively enlarged.

An electric lighting system is under consideration for Danville, N. Y.

Irving Kraft, of Louisville, Ky., may erect a cotton-mill at North Carolina.

The McFadden Compress Company will establish a large compress at Temple, Tex.

A $50,000 company may be incorporated to establish a linen-mill at Frankfort, N. Y.

The Union Warehouse and Storage Company, of Houston, Tex., will erect a cotton compress at Temple, Tex.

T. R. Almond, of Brooklyn, N. Y., reports business decidedly better in his specialties, drill chucks, turret heads for lathes and flexible metallic tubing.

The Hendey Machine Co., of Torrington, Conn., report that trade for the past two months has been good, that their export trade holds up well and the home trade is steadily increasing.

The John Becker Mfg. Co., Fitchburg, Mass., write us that business is much improved with them of late, and that they have had to increase their force of workmen and run until 10 P. M. for about three weeks past to save orders.

The New England Electrolytic Copper Co., at Central Falls, R. I., have just completed an addition to their works, which addition is made entirely of iron and steel, furnished by The Berlin Iron Bridge Co., of East Berlin, Conn.

The National Wheel Company, Indianapolis, Ind., which now has a capacity to turn out fifty sets of wheels a day, is to double its capacity at once. The works are not in the trust, and parties have offered to take their entire output, if they increase it to two hundred sets a day.

The Egan Co., of Cincinnati, Ohio, have recently received an order from Burmah, India, for woodworking machinery. It is this country which is the source of the teak wood, which is largely used in England for ship-building. In handling the timber in Burmah elephants are employed to do the piling, loading and hauling together, etc.

The new machine shop for The American Hard Fiber Co., at Newark, Del., is now completed. It is designed and built by The Berlin Iron Bridge Co., of East Berlin, Conn., and is 50 feet wide by 220 feet long, the roof being made of steel, and covered with The Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof covering.

The Foster Engineering Co., of Newark, N. J., have entered an order from the Messrs. Cramp & Sons, for the equipment of the great American liner "St. Louis" with their Foster pressure regulators. The order for immediate requirements includes six 8-inch—which are the largest valves the Foster Company have ever made for steamship service—eight 5-inch and others of smaller sizes.

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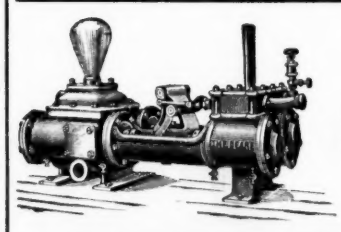

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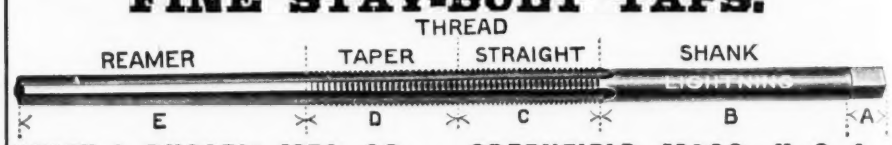

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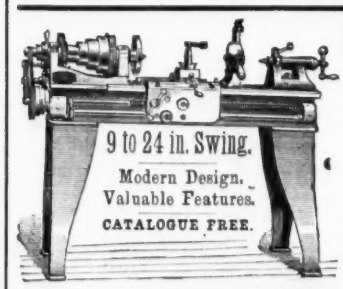

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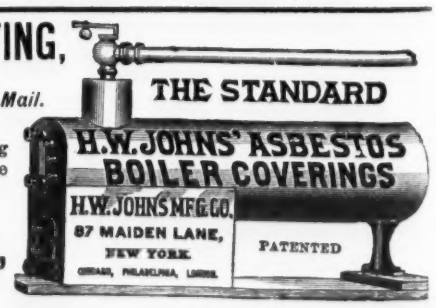


We have received from the Sperry Electric Railway Co., Cleveland, Ohio, an exceptionally fine catalogue (standard size 6"x9"), which is devoted to setting forth the advantages peculiar to the Sperry system of apparatus for electric street railways. It will be found of interest to all who have to do with the manufacture or use of such apparatus, and is sent to those interested upon application.

Chas. Churchill & Co., of London, in a recent letter to this office say: We have pleasure also in reporting that our sales during the last 12 months have exceeded by 20 per cent. those of the previous year, which will show to you American tools are still moving on this side, and every day they are more and more appreciated. We think this in the face of the general complaints of dull trade is very satisfactory.

We have received from the Interior Telephone Co., 203 Broadway, New York, a catalogue illustrating and describing the Colvin system of interior telephones. This is a system of telephones devised especially for intercommunication between different departments of business houses, offices and manufactories, and the catalogue contains letters from a number of well known manufacturing concerns certifying to its advantages for that purpose. It is sent to those interested on application.

It is announced that one of the largest steel concerns in the country is to be located at Buffalo, and that work will commence on the buildings early in the coming year. The concern will be known as the American Structural Steel Co., and H. Sellers McKee, a prominent manufacturer of Pittsburgh; Murray A. Verner, of Buffalo, and others will be interested. It is said that the new concern controls patents by which square columns of steel are made in one piece instead of being riveted together, as is the present practice, and that such a beam by the new process can be made at a much lower cost than by the present method. It is expected that the buildings will cover 26 acres of land and will cost about $900,000, and that when running in full operation they will employ 2,500 men.

The Tradesman, Chattanooga, Tenn., in its report on the industrial condition of the South for the week ending November 12th, says: It is believed by furnace operators that there will be an active demand for pig-iron from this time forward, and arrangements are being made to put more furnaces into blast. Business in the iron and coal producing districts is now quite active, although prices rule very low. Cotton-mill operators report that the market for fine goods exceeds the supply, and that common grades are in good demand. Organizations among lumber men are slowly increasing prices, but there is room for much improvement. Low-priced cotton and the holding back of the crop, makes mercantile business quiet. *The Tradesman* reports 42 new industries as established or incorporated during the week, together with nine enlargements of manufactories, and eight important new buildings. Among important new industries to be established are: The Braddock Land and Granite Co., of Little Rock, Ark., capital $300 000; the Moreau-Walbrette Shoe Co., of New Orleans, La., capital $150,000; an electric power plant in New Orleans to cost $50,000; a $50,000 paint manufacturing company in Atlanta, Ga.; a $25,000 cotton compress in Birmingham, Ala.; a $10,000 cannery in Cameron, N. C., and a $10,000 gin and mill in Alvarado, Texas. *The Tradesman* also reports a cannery at Mount Airy, N. C.; cotton mills at Mobile, Ala., Central and Greenville, S. C.; electrical plants at De Land and Palatka, Fla., and flour and grist-mills at Guthrie and Harrodsburg, Ky., Angleton, Tex., and Jack's Mills, Rockbridge Baths and Timber Ridge, Va. Foundries and machine shops are reported at Eufaula and Huntsville, Ala.; a furnace and rolling-mill at Galveston, Tex.; ice factories at De Land, Fla., and Union City, Tenn. Iron mines are to be opened at Cedartown, Ga., and gold mines near Hickory, N. C. A plow factory will be built at Chipley, Fla.; pump works at Charlotte, N. C.; a spirit refinery at Louisville, Ky.; a rice-mill at New Orleans, La.; smelting works at Yellville, Ark.; soap factories at Huntsville, Ala., Corydon, Ky., and West Point, Miss.; a sugar-mill at Webster, Tex., and saw and planing-mills at Waycross, Ga., and Durant, Miss. Water-works are to be built at Carrollton and Lawrenceburg, Ky.

Machinists' Supplies and Iron.

NEW YORK, November 17, 1894.

Iron—American Pig—We quote standard brands, $12.25 to $12.50 for No. 1; $11 to $12 for No. 2. Southern brands, $11.50 to $12 for No. 1; $10.50 to $11.25 for No. 2; $10.25 to $10.75 for No. 3; $10.75 to $11 for No. 1 soft; $10 50 to $10.75 for No. 2 soft; and Foundry No. 4, $10 to $10.40.

Antimony—The market is steady with a fair demand. We quote L. X., 8⅜c. to 8½c.; Cookson's, 9c. to 9¼c.; Hallett's, 7½c. to 7⅝c.; and U. S. French Star, 9¼c. to 9½c.

Lard Oil—Prime City we quote at 57c. to 59c.

Copper—The market is dull, with scarcely any demand. Lake companies quote 9¾c., but Lake Copper can be obtained from second hands at 9½c. easily. Casting Copper is held at 9½c.

Lead—There is no change in the market. Quotations for New York delivery are 3½c., and a few holders are willing to sell at 3.10c.

Spelter—The prices have declined; spelter can easily be bought in New York for 3.35c.

Tin—The market is dull, the consumer's demand is only fair. For spot and current month delivery 14.55c. to 14.60c. is quoted.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

A mach. shop supt. of superior ability desires to make a change; cor'd'e solic'd. Box 25, AM. MACH.

Mass. Inst. Tech. graduate in mechanical eng., wants position. Address Box 163, Taunton, Mass.

Good draftsman and designer grad. wants change position. N. Y. vicinity pref'd. Box 50, AM. MACH.

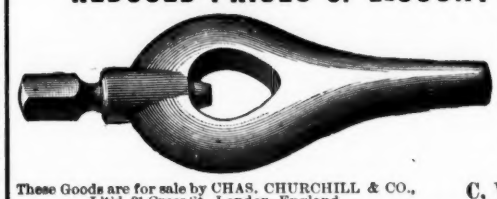
Wanted—By an M. E. graduate, with two years' experience in manufacturing, a position with consulting or contracting eng'r. Box 41, AM. MACH.

Draftsman, with 13 yrs. A1 pattern and gen. shop exp., tech. education, wants position; age 31; steel works preferred. E. F., AMERICAN MACHINIST.

Wanted—Draftsman and machinist with technical training desires a change either as draftsman or foreman. Address X. Y., AMERICAN MACHINIST.

[*Continued on Page* 14]

REDUCED PRICES OF LeCOUNT'S STRAIGHT TAIL DOG.



To be driven from a Stud in the Face Plate.

No.	INCH.	PRICE.	No.	INCH.	PRICE.
1	¾	$0.60	10	2¼	$1.35
2	⅞	.70	11	2½	1.45
3	1	.70	12	3	1.60
4	1⅛	.80	13	3½	1.80
5	1¼	.80	14	4	2.10
6	1⅜	.95	15	4½	2.75
7	1½	.95	16	5	3.25
8	1¾	1.10	17	5½	4.00
9	2	1.20	18	6	5.00
1 Set to 2 in.		7.80	Full Set.		31.10

These Goods are for sale by CHAS. CHURCHILL & CO., L't'd, 21 Cross St., London, England.

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INSIST ON HAVING
NICHOLSON.

NICHOLSON FILE CO.
PROVIDENCE, R. I., U. S. A.
3000
VARIETIES FILES
[X. F.] & INCREMENT CUT FILES.

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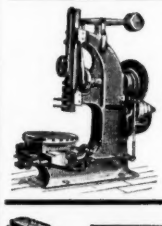

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JESSOP'S STEEL
FOR TOOLS, DRILLS, DIES, &c.
ALL KINDS IN STOCK.
Manufactory, SHEFFIELD, ENG.
Chief Am. Office, 91 JOHN ST., N. Y.
WM. JESSOP & SONS, LTD.
Established a century ago.
Medal World's Columbian Exposition 1893.

"COLUMBIA" VERNIER CALIPERS, Etc.
OVER 12,000 IN USE.
Graduated in Inches or Metric System.
Using them results in Better and More Work!
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No. 8 Railroad Ave., East Berlin, Conn.
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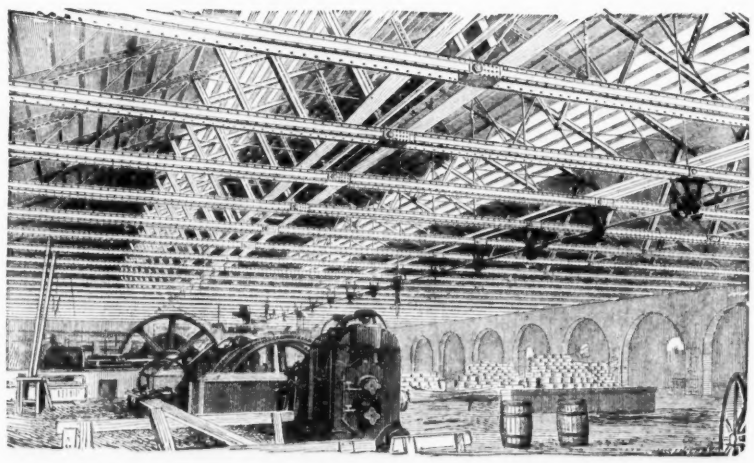
FRANK L. WILCOX, Treasurer. GEO. H. SAGE, Secretary.

Engineers, Architects and Builders of



Iron and Steel Bridges and Buildings.

The above illustration is taken direct from a photograph, and shows the construction of an Iron Truss Roof designed and built by us for the Coe Brass Co., at Torrington, Conn. The Roof is over their Rolling Mill, which is a building 118 feet wide and 233 feet long. The line of brick arches, shown on the right, connects with an adjoining Muffle Room, which is also covered with an Iron Truss Roof designed and built by us.

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Tools, Supplies and Machinery,
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"Star" Foot Lathe Swings 9x25 in.

LA THE

Screw Cutting Automatic Cross Feed, etc.

LATHE

Scroll Saws, Circular Saws, Lathes Mortisers.

Catalogue Free of all our Machinery.

Seneca Falls Mfg. Co., 687 Water St., Seneca Falls, N.Y.

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In order to reduce stock before our annual stock-taking, we have decided to make special LOW PRICES on such new and second-hand tools as we have in stock, if ordered on or before January 10, 1895. WE MEAN BUSINESS. Send for list and state what tools you are in the market for.

FITCHBURG MACHINE WORKS, Fitchburg, Mass.

BUILDERS IRON FOUNDRY,
(Patented.)
PROVIDENCE, R. I.

GLOBE SPECIAL CASTINGS FOR WATER-WORKS, MILLS AND RAILROADS.
"I think they are the most practical special in use at the present time."
All common sizes in stock. Catalogue mailed on application.
M. J. DRUMMOND, SALES AGENT, 192 BROADWAY, NEW YORK CITY.

CHATTANOOGA DOUBLE STRENGTH
WOOD SPLIT PULLEYS.
Lighter, Better and Cheaper than Iron.
Oval Bushings, Nailed Segments.

A LARGE STOCK CARRIED BY
COOKE & CO.,
163 & 165 Washington St.,
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INDUSTRIAL PUBLISHERS, BOOKSELLERS AND IMPORTERS,
810 Walnut St., Philadelphia.
☞ Our New and Revised Catalogue of Practical and Scientific Books, 88 pages 8vo., and our other Catalogues and Circulars, the whole covering every branch of Science applied to the Arts, sent free and free of postage to any one in any part of the world who will furnish his address.

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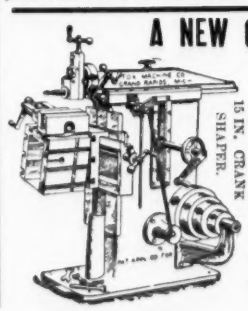

NOVEL, YET SIMPLE.
Length of stroke changed INSTANTANEOUSLY while IN MOTION.
Get Photos & Prices.
NOTHING LIKE IT.
Fox Machine Co.,
325 Nor. Front St.,
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135 Finsbury Pavement, London, England.

P.H.& F.M.ROOTS,
Connersville, Indiana.
Chicago Office, 1405-10 Manhattan Building.
MANUFACTURERS OF
PORTABLE FORGES, TUYERE IRONS, ETC.

ROOTS' NEW ACME HAND BLOWERS
Slow speeded, Force-blast, Durable, Compact and Cheap.
Roots' Foundry Blowers, Gas Exhausters, etc.
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WORTHINGTON PUMPING ENGINE
FOR
WATER WORKS.
SIMPLE, COMPOUND, OR TRIPLE EXPANSION, HORIZONTAL OR VERTICAL
HIGHEST DUTY GUARANTEED.
COMPLETE DESCRIPTIVE PAMPHLETS ON APPLICATION.
HENRY R. WORTHINGTON,
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BOSTON, 70 Kilby St.
PHILADELPHIA, 607 Arch St.
CLEVELAND, 24 South Water St.
CHICAGO, 185 to 189 Van Buren St.
ST. LOUIS, Eighth and St. Charles Sts.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Wanted—One or two good loam molders, familiar with water-works specials. Address the Radford Pipe and Foundry Co., Radford, Va.

Tech. grad., several years experience in drafting room & shop with knowledge of jig & interchange methods, would like position; foremanship of small shop preferred. Address Shop, care of AM. MACH.

Situation wanted by mech. eng'r, with exp. as machinist, erecting engineer, head draftsman, and supt.; record for economical production of work; moderate salary; good ref. Box 42, AM. MACHINIST.

First-class agents wanted to sell boiler attachment placed on two months' trial: commission paid to agent when machine is attached whether accepted or not; only good salesmen need apply. Cook A. B. C. Co., Fort Wayne, Indiana.

As business manager of machine works. Wanted a first-class pos. by gentleman who is thoroughly practical in all the departments, able and reliable in business matters; 30 years exp., covering many lines of machinery; unexceptionable references. R. Wadsworth, 801 63d street., Englewood, Ill.

Wanted—Position as supt. mach. shop and foundry; have had extended experience manufacturing machinery, repairing and selling; mixing and melting irons for gray iron castings, rolling-mill rolls, car wheels & malleable iron; also gen. shop details; a hustler; A1 references. J. B. L., care of AM. MACH.

Wanted immediately—A competent exp'd man to take charge of our machine room, empl'g about 100 men; prefer a man who has had experience in bicycle work or screw machine work; permanent place at a good salary for suitable man; the best of reference will be required. Eclipse Bicycle Co., Beaver Falls, Pa.

A young man of good address and business ability well established in San Francisco and Pacific Coast, with references from leading houses and employed by one of them, desires to represent manufacturer or jobber in that territory on salary or commission basis. New York and Eastern references given. Box 49, AMERICAN MACHINIST.

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Advertisements will be inserted under this head at 35 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M.York, Clev'd, O.

Auto. Steam Flue Cleaners. Kelley Co., Erie, Pa.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Co., Cincinnati, O.

Light and fine machinery to order; Foot Lathe Catalogue for stamp. E. O. Chase, Newark, N. J.

Wanted—To buy good second-hand tools. Box 83, AMERICAN MACHINIST.

Draftsmen's new novel combination triangles, stencils, etc. D. J. Kelsey, New Haven, Conn.

Model Locomotive Castings. Latest design. G. H. Olney, 163 Herkimer street, Brooklyn, N. Y.

For Sale—8 vols. *Am. Mach.* 1 vol. *Sc'fic Am'n* unbound; good; price, $10. J. P. R., care AM. MACH.

Every mechanic should have a copy of "Pocket Primer of the Air Brake." Sent to any address for 50 cents. W. S. Rogers, Buffalo, N. Y.

Wanted—An iron planer 4 feet by 4 feet by 14 feet of improved pattern and standard make, with two heads of the rail and two side heads; good second-hand planer will answer the purpose. Box 43, AMERICAN MACHINIST.

CLEVELAND TWIST DRILL CO'S. GRIP SOCKETS. No More Twisted Tangs.

Larger drills can be used with smaller shanks than ever before. No charge for the groove in the shanks.

Send for Descriptive Price List.

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Manufacturers of Set, Cap & Machine Screws, Studs, etc.

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SOLE MANUFACTURERS OF

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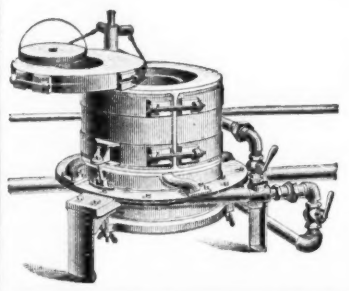
Endorsed by Practical Mechanics Everywhere. Send for Catalogue



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Gas Blast Furnaces & High Pressure Blowers

For the economical generation and systematic application of HEAT.

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16 in. x 6 ft. Blaisdell.
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18 in. x 6 ft. New Haven.
18 in. x 6 ft. Bradford.
18 in. x 8 ft. Blaisdell
18 in. x 8 ft. Wamesit.
18 in. x 10 ft. Blaisdell.
18 in. x 9 ft. D. W. Pond.
20 in. x 6 ft. Bullard.
24 in. x 12 ft. Geo. Gage.
29 in. x 12 ft. Fifield.

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20 in. x 20 in. x 5 ft. Ames.
22 in. x 22 in. x 4 ft. L. W. Pond.
24 in. x 24 in. x 6 ft. Whitcomb.
24 in. x 24 in. x 5 ft. Putnam
28 in. x 28 in. x 7 ft. New Haven.

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10 in. Juengst Crank.
10 in. Wood and Light Traverse Head.
18 in. Putnam Traverse Head.
24 in. Hendey Friction

HAND LATHES.

4 10 in. x 41 in. Garvin.
1 12 in. x 4 ft. Garvin.
1 12 in. x 5 ft. Back Geared.
1 20 in. x 6 ft. Back Geared.

MISCELLANEOUS.

Garvin Profiler, one Spindle.
6 in. Bement Slotter.
36 in. Gould & E. Automatic Gear Cutter.
26 in. Pulley Lathe.
50 in. Pulley Lathe.
5 in. Cutting-off Machine.
No. 2 Springfield Tool Grinder.
No. 1 Garvin Screw Machine.
3 in. Squaring Shear.
14 ft. Power Draw Press.
150 lb. Gould & E. Drop Press
No. 2 Garvin Cutter and Drill Grinder
No. 1 Bit or Marking Machine.
No. 2 Garvin Automatic Tapper.
No. 4 Sturtevant Blower.
Garvin Wire Spring Coiler
Several Wood-working Machines.

Also, a large number of other machines. Write for complete list and detailed description.

THE GARVIN MACHINE CO.,

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Also, 51 North 7th St., Philadelphia, Pa.

NEW AND SECOND HAND.

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12 in. x 4 ft. Manhattan Co.
14 in. x 6 ft. Old Style
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16 in. x 8 ft. Blaisdell.
19 in. x 6 ft. Pratt & Whitney.
21 in. x 11 ft. Lodge & Davis.
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24 in. x 12 ft. Special heavy pattern.
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12 in. and 15 in. Lever and Screw Movement to Turret.
18 in. Turret Chucking
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20 in. Lever Drill.
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52 in. Comb Radial.
120 in. Radial.
Henley Swing Drill.

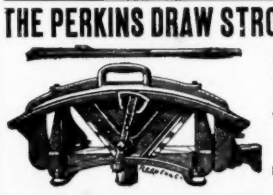
MISCELLANEOUS.

2 No. 1 Garvin Tapping Mach.
1 No. 2 Garvin Tapping Mach.
1 Open Die Header for Heading Bicycle Spokes.
1 Garvin Screw Slotter.
New Imp'v'd Engine Lathes.
Turret, Brass Working and Pulley Machinery.

THE LODGE & SHIPLEY M. T. CO.,

CINCINNATI, O., U. S. A.

THE PERKINS DRAW STROKE TRIMMER,



An Indispensable Tool for all Bench Woodworkers. Latest and Best Design. Infringers Prosecuted. Trial, no orders, solicited.

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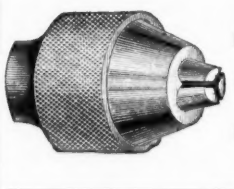
Grand Rapids, Mich.

STOCKS, NEAVE & CO., Manchester, England.



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Sold at all Machinists' Supply Stores.

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Machinery and Apparatus Designed.

Automatic Devices a Specialty.

Electrical Inventions Developed.

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73 Hathaway Building, Boston, Mass.

Machine and Boiler Tools,

MODERN STYLE, AT LOW PRICES.

IRON PLANERS.

19 in. x 3 ft. Wheeler.
20 " x 6 " Pratt & Whitney
22 " x 5 " Pease
24 " x 4 " Wood & Light.
24 " x 5 " New Haven.
24 " x 6 " Wood & Light.
26 " x 7 " N. Y. S. Eng. Co
27 " x 5 " Pond
30 " x 10 " Bancroft heavy A1
36 " x 12 " Powell.
60 " x 24 " Steam Eng. Co.

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9 in. Stroke Hewes & Phil.
9 " " Gould.
16 " " Gould & Eber.
22 " " Triple Geared.

DRILLS.

1 Spindle Imp. Sensitive.
20 in. Swing Wheel Feed
25 " " Prentice, complete.
48 " " Old Style
Radial Drills 54 and 66 in.
Universal Radial 96 in.

MILLING MACHINES.

Brown & Sharpe No. 6. Plain.
Brainerd Plain, Table 30 x 8.
Brown & Sharpe No. 1 Universal.
Lincoln Pattern, very cheap.

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Bement No. 2 Hor. B. & D.
Bement Cyl. Borer, 12 to 36 in.
Upright Boring and Turning Mill 38 in. Good as new
Brown & Sharpe Upright Turret Borer, takes in 36 x 12 in.

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13 in. x 6 ft. Blaisdell
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15 " x 5 " Pond.
15 " x 8 " Standard.
16 " x 6 " Ames.
16 " x 6 " Putnam.
18 " x 8 " Standard.
20 " x 10 " Fitchburg
20 " x 12 " Prentiss Taper.
22 " x 10 " Putnam.
24 " x 12 " Putnam.
30 " x 16 " Perkins.
35 " x 15 " Hewes & Phillips.

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100 lb. Stiles "Frie. Drop."
800 " "Steam" Ferris & Miles.

BOILER AND BRIDGE TOOLS.

Rolls, 7, 8 and 10 ft.
Hor. Flange Punch, "H and J."
Bement Plate Planer 16 ft.
Allen Pneu. Bridge Riveter with reach of 60 in.
Allen Bridge Riveter, 25 in.
" " " 34 "

MISCELLANEOUS.

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Acme, 1 in. Bolt Cutter with Dies, Nut Taps, Chuck etc.
Slotters 10 and 18 in. Stroke.
Gear Cutter 36 in., ex. heavy.
Screw Machine, 2 in. hole.
Screw Machine No 2. Wire feed.
Putnam Cutter Grinder.
Univ. Grinder "Small" with all attachments. Good as new.

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SUCCESSOR TO
E. P. BULLARD'S N. Y. Mach'y Warerooms.

14 Dey St., NEW YORK.

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10 in. Post Drill.
10 " " Auto. Feed to Table. for Butt Drilling.
1, 2 and 3 Spindle Sensitive with and without Power Feed.
2, 3 and 4 Spindle Gang Drills
20 24, 26, 28, 30 and 44 in. "
60 in. Swing Post Drill.
5 ft. Arm Radial Drill.
12 in. Stroke, 16 in. x 16 in. Crank Planer.
16 in. x 4 ft. Planer.
24 " 4, 5 and 6 ft. Planer.
28 " 5 and 8 " "
30 " 5, 8 and 10 " "
60 " 20 " "
72 " 25 " "
9, 12, 16 24 and 26 in. Stroke Shaper.
10 in. Stroke Slotter.
Hyd. Rivetting Machine.
" Crane, Both Ai.
Punch and Shear.
Plate Planer
Hor. Flange Punch No 2 H. & J.
Thomson Bevelling Shear.
15 Swing 6 and 8 ft. Eng. Lathe.
16 " 5, 6, 7 and 10 ft. Eng. "
18 " 6 7 and 8 " "
20 " 5, 6, 7 8 and 10 ft. " "
21 " 10 and 13½ ft. " "
24 " 10 " "
25 " 16 and 24 " " "
32 " 16 " " "
52 " 35 " " "
57 in. Double Head Driving Wheel Lathe.
88 in. x 20 ft. Engine Lathe.
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1¼ & 2 in. Bolt Cutter Schenk's
7 Spd'l Nut Tapper, Dunel.
2 Spd'l Profiler, No. 1 P. & W.
No. 1, 2 and 2½ Screw Machs. P. & W.
No. 1 Lincoln Pattern Miller.
Hand Millers, Screw Slotters, Mill and Cutter Grinders.
No. 2 Garvin Universal Miller.
80 200 lb Helve Ham'r, Bradley.
200 lb. Upright " "
1,100 and 1,500 lb. Steam Hammer, Morgan.

Lot of Miscellaneous Machinery, Engines, etc. Send for Latest List.

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THE ANDREW PATENT GRIP SOCKET.

Pat'd May 14, '89. Sept. 4, '94.

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M. L. ANDREW & CO., Cincinnati, Ohio.

IF YOU WANT ANYTHING IN THE LINE OF
DROP PRESSES, DROP HAMMERS, STAMPS OR AUTOMATIC DROP LIFTERS.
SEND FOR CATALOGUE TO
Miner & Peck Mfg. Co.
NEW HAVEN, CONN.
LARGEST LINE IN THE MARKET

WANTED

TO BUY FOR CASH.

First-class Second-hand Engine Lathes, Planers, Drill Presses, Shapers, Milling Machines, etc., address,

The Fosdick & Plucker Machine Tool Co.,
CINCINNATI, OHIO.

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By J. G. A. MEYER.

The demand for back numbers of the **American Machinist**, containing this valuable series of articles, has been so great, that, notwithstanding it has compelled us to issue special reprints of several of the articles, our stock is now limited to complete sets, with the exception of two or three issues, and orders can hereafter be filled **by the set only.**

A number of engineering schools are using these articles in lieu of a text book on this important branch of mechanics.

The set of 92 papers will be sent by mail to any address in the U.S., Canada or Mexico for $5 00, postpaid, and to any foreign country for $7.00.

Order now before our stock of papers is exhausted.

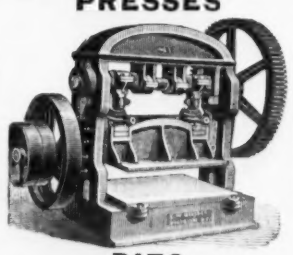
ADDRESS:

American Machinist,
203 BROADWAY,
NEW YORK.

E. W. BLISS CO.

1 ADAMS ST., BROOKLYN, N. Y.
Chicago Office, 100 W. Washington Street.

PRESSES



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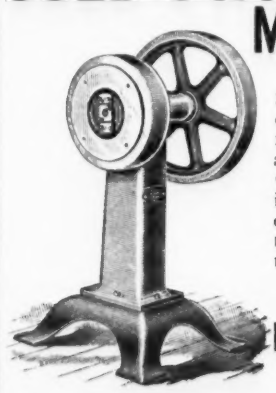
DIES

AND SPECIAL MACHINERY.

The STILES & PARKER PRESS CO.

COLD SWAGING MACHINE



The Dayton Swaging Machine is the best for reducing and pointing wire and tubing. If interested address the manufacturers,

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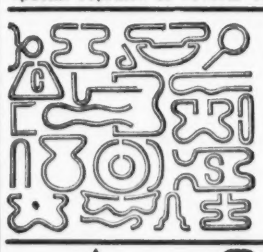

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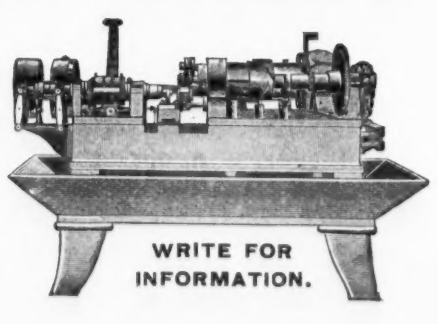

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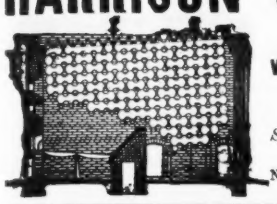

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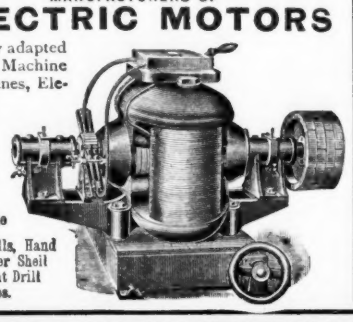

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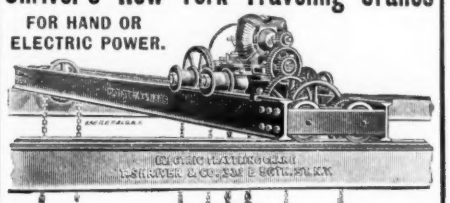

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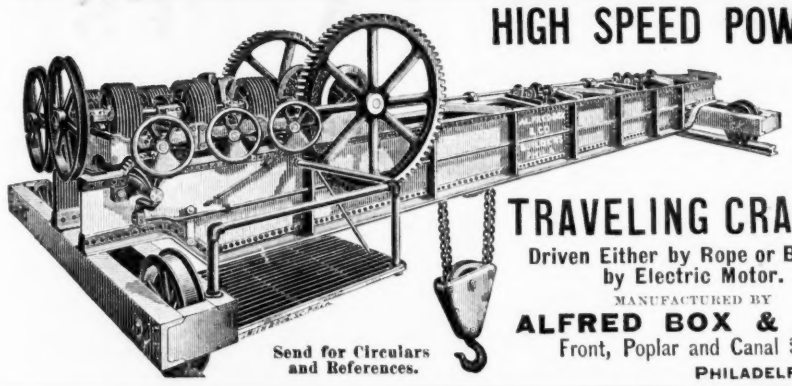

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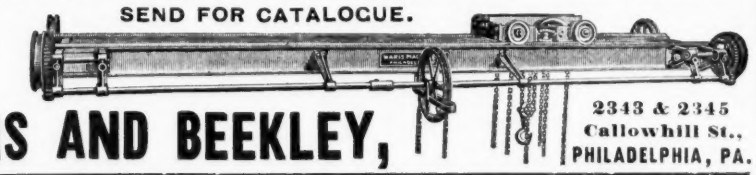

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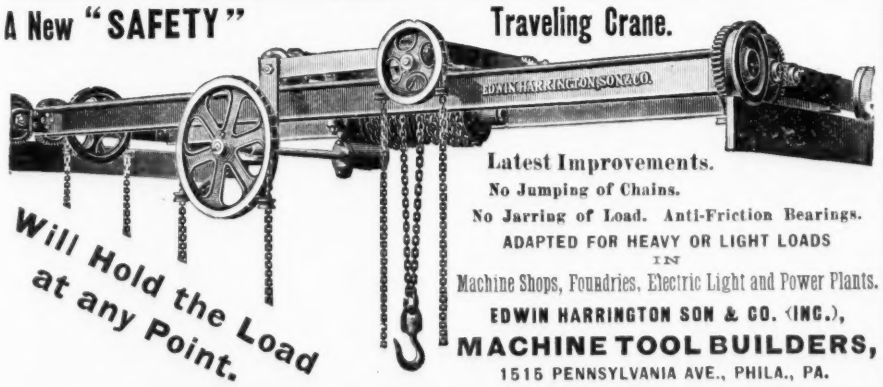

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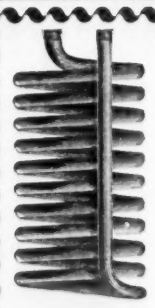

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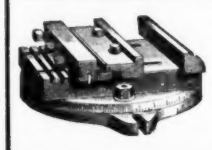

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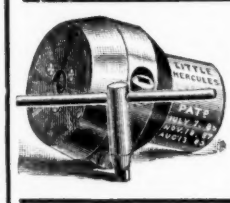

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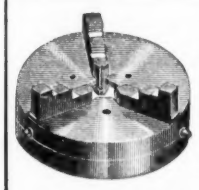

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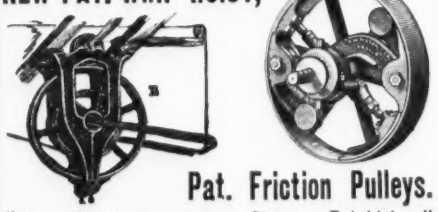

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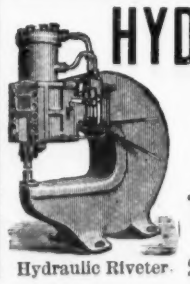

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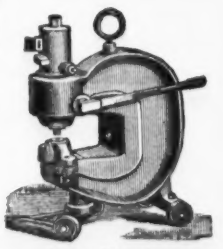

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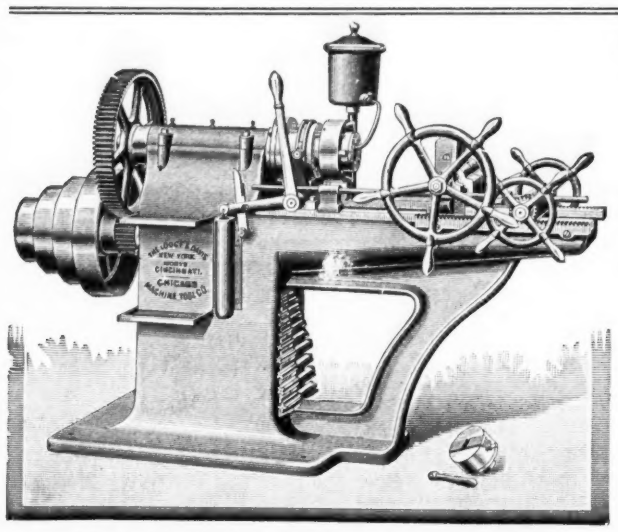

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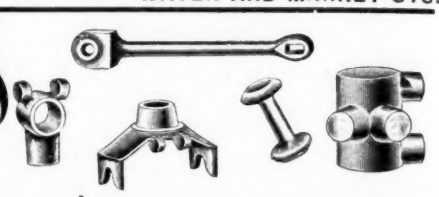

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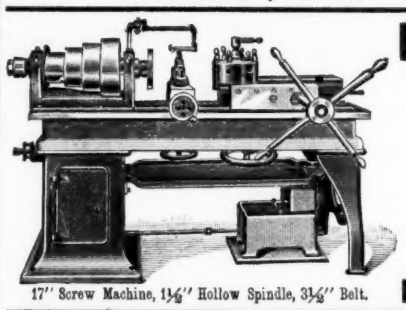

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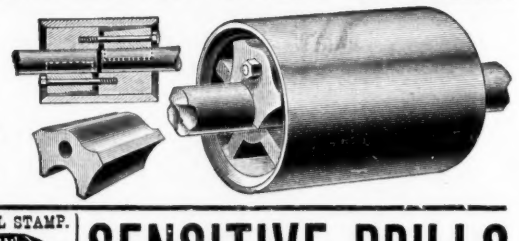

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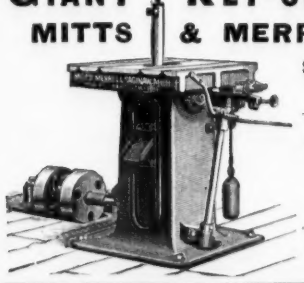

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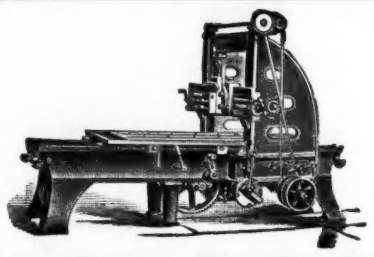

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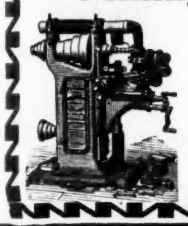

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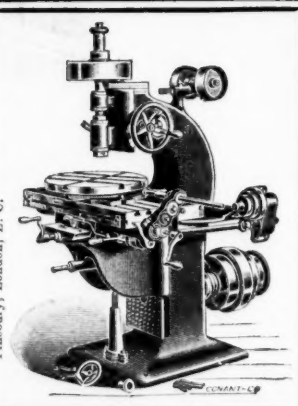

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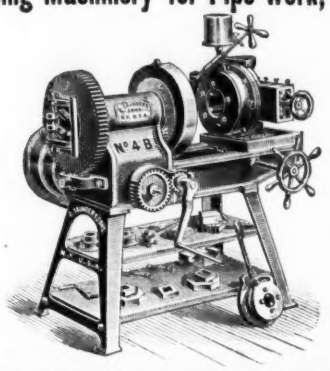

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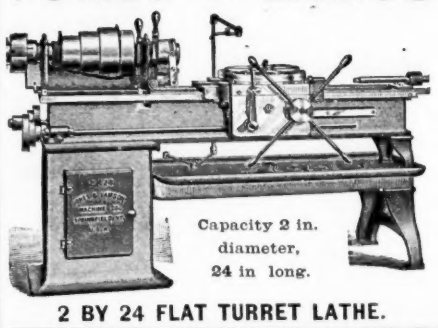

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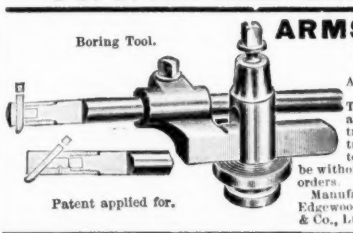

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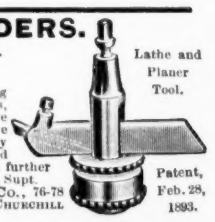

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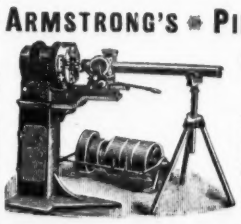

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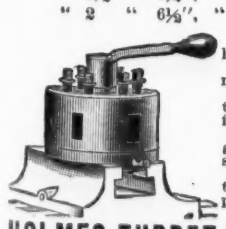

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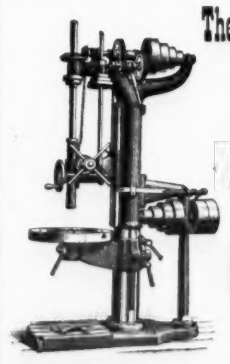

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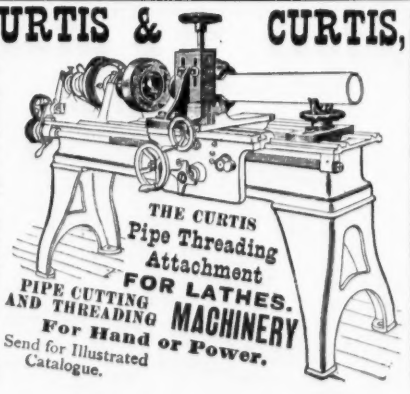

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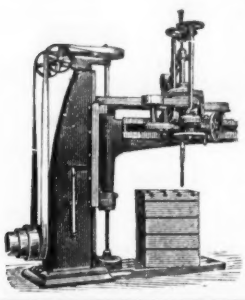

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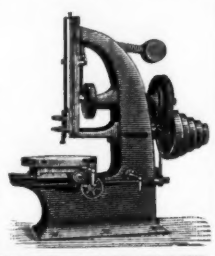

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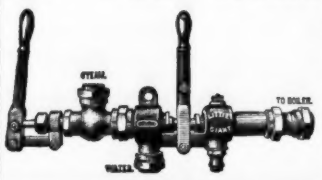

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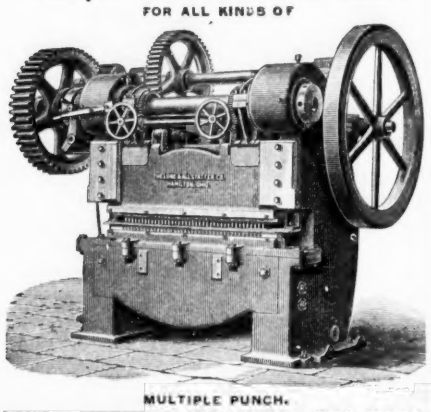

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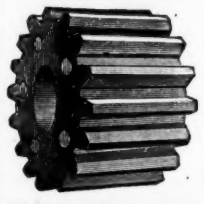

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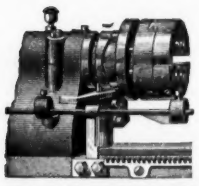

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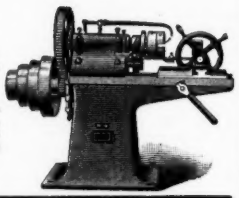

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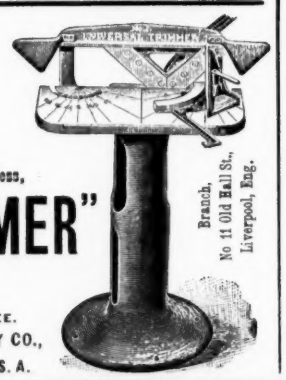

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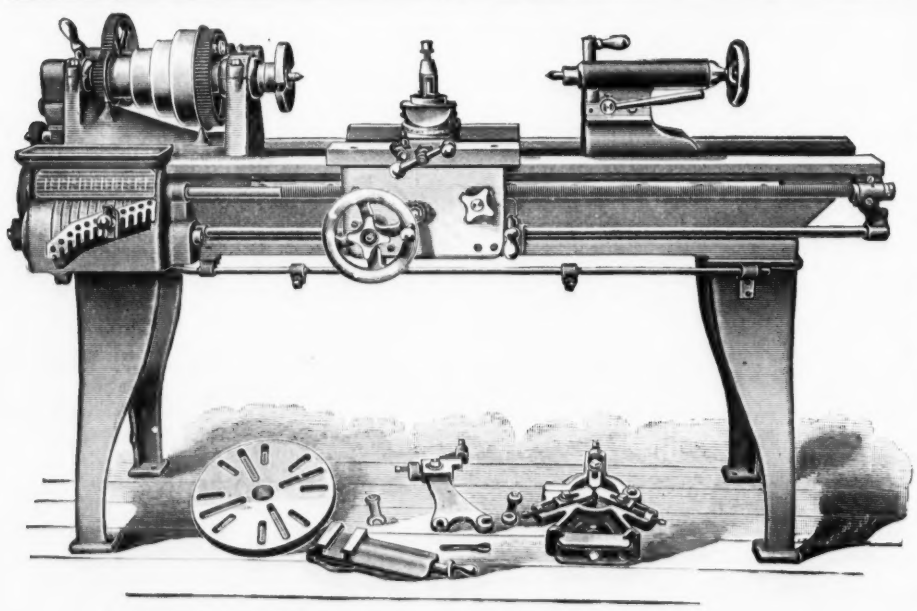

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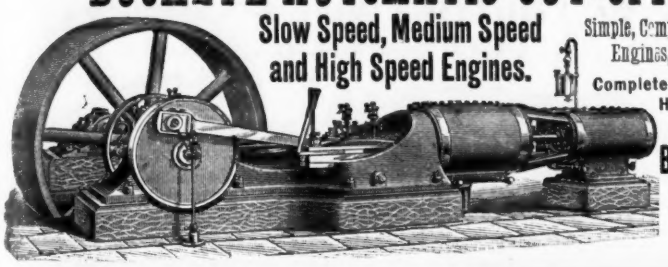

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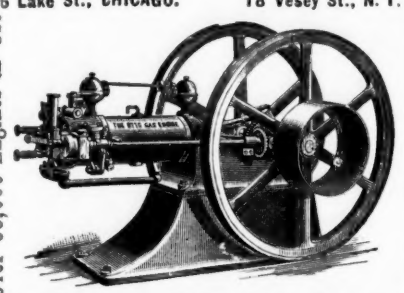

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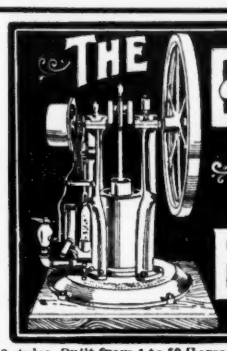

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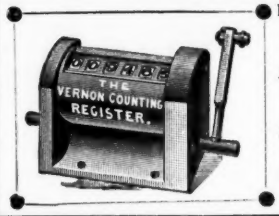

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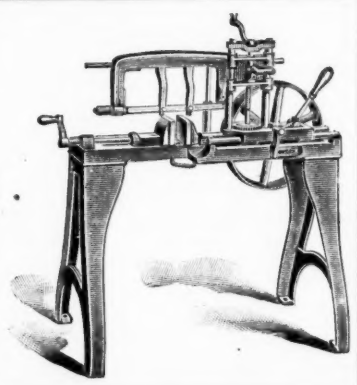

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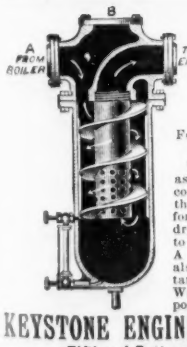

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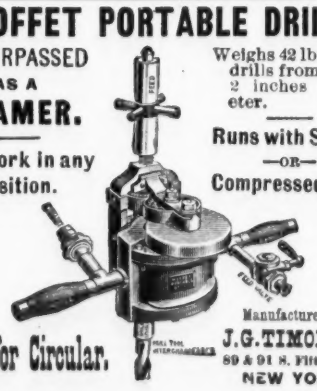

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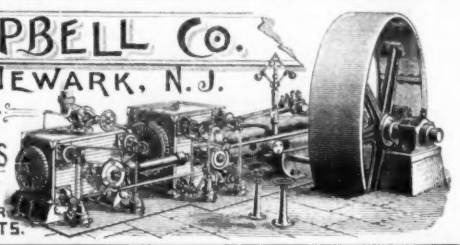

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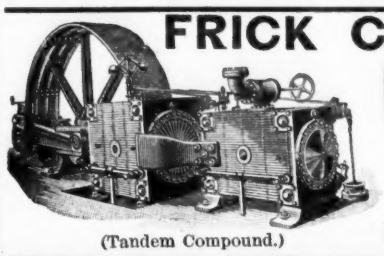

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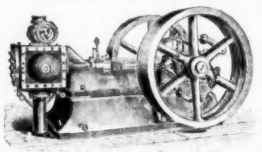

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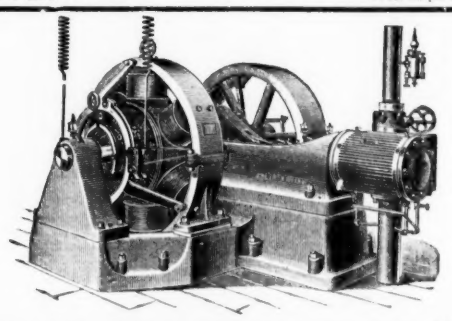

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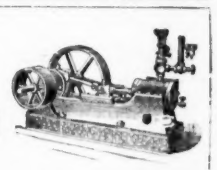

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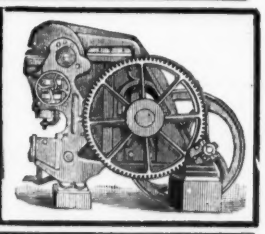

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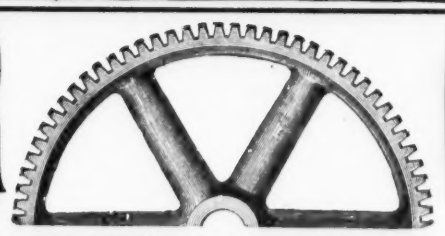

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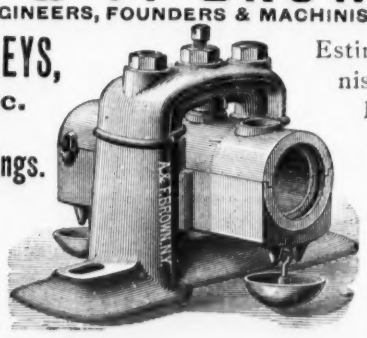

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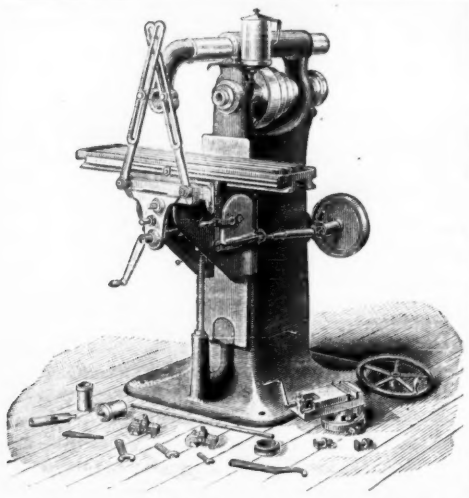

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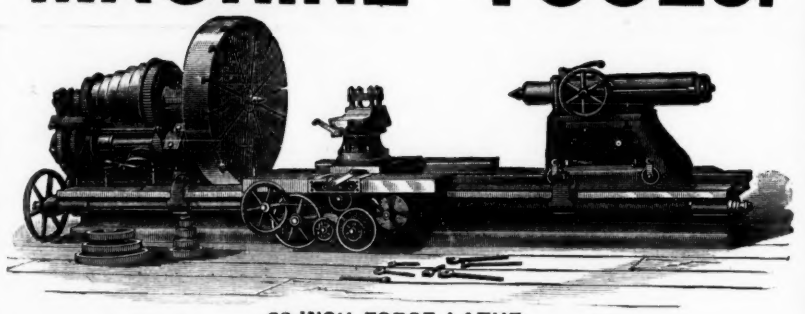

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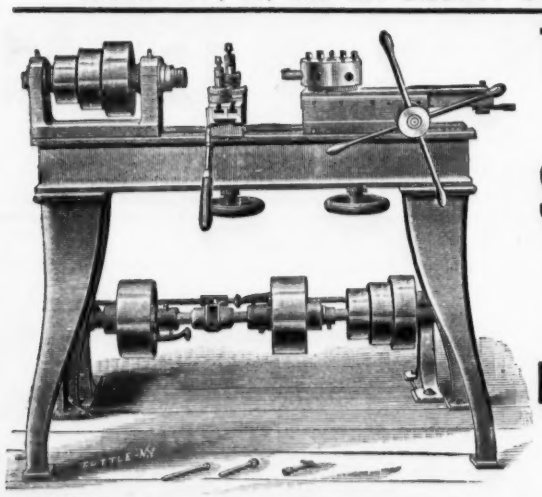

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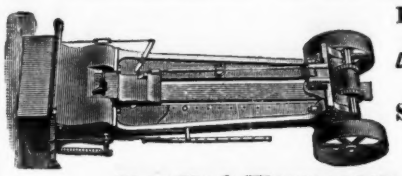

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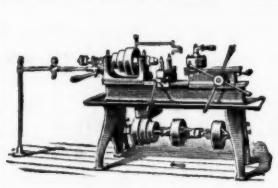

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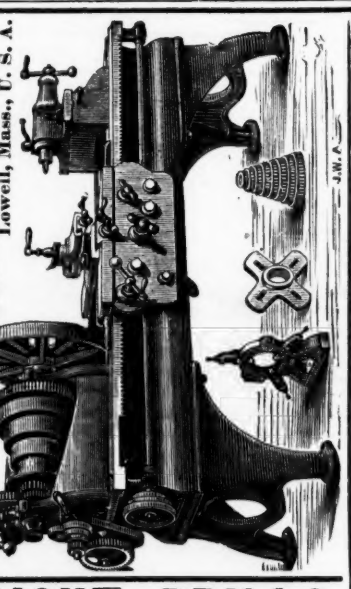

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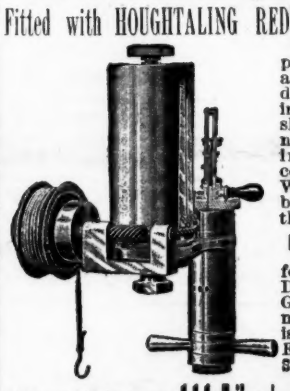

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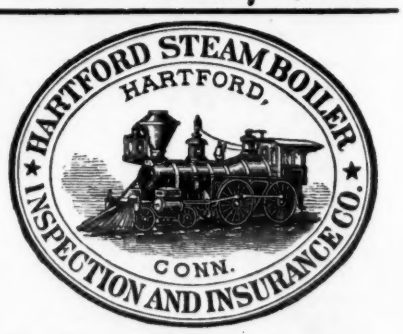

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